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REPORT

MADE TO THE

Water Commissioners of the City of Albany,

AUGUST 1, 1850,

ON THE

PROPOSED PROJECTS

FOR

SUPPLYING THE CITY WITH WATER.

BY
WILLIAM J. McALPINE,
CIVIL ENGINEER.

ALBANY:
H. H. VAN DYCK, PRINTER.
1850.

Eng 1078.30

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James R. Baldwin

REPORT.

ALBANY, AUGUST 1, 1850.

To JAMES STEVENSON, ERASTUS CORNING, JOHN TOWNSEND, JOHN TAYLOR and ROBERT E. TEMPLE, ESQ'RS,
Water Commissioners of the City of Albany:

GENTLEMEN:

The surveys and estimates for the several plans for supplying the city of Albany with water, are now completed, and are herewith submitted.

A party was organized, and the surveys were commenced on the 21st of May last, but the weather continued so stormy, that it greatly embarrassed the operations in the field and rendered it very difficult to make the desired examinations of some of the most important questions involved, and particularly to obtain the guages of the streams.

All of the essential features of the several plans have been developed, so as to show that an abundant supply of pure water, distributed equally to each tenement, can be obtained at a moderate cost.

The question of supplying the city with water has already been examined by a number of Engineers, who have reported on various projects.

I have been furnished with the following Reports made by these gentlemen, viz.:

1st. In 1841, by Mr. Cushman, from the Mohawk river at Cohoes; and in 1842, from the Hudson river, near the mouth of Patroon's creek.

2d. In 1845, by Major Douglass, from the Patroon's creek, near Tivoli; from the Hudson river, near the north end of the city, and from the Mohawk river at Cohoes.

3d. In 1849, by Mr. Claxton, from the Mohawk at Cohoes; by Mr. Carpenter, from the Hudson near the north end of the city; by Mr. Perkins, from the Hunger kill in Guilderland; and by the late Water Commissioners, from the Patroon's creek, near the junction of the branch of the Mohawk and Hudson Railroad, and also near the mouth of Sand creek.

Modifications of these several plans have been suggested by practical and intelligent gentlemen, who have given the subject attention.

The deep interest which is felt by the citizens in the general subject, has led to these examinations, and, to a considerable extent, strongly enlisted them in favor of some one of the plans.

After some consideration of the subject, it appeared that three of the projects presented nearly equal advantages, so far as could be judged by the surveys which had already been made, and after consultation with your Board, it was determined to confine the examination, at first, to them, in the following order, viz.:

1*st. To the Hudson river.*

2*d. To the Patroon's creek.*

3*d. To the Hunger kill and the intermediate streams.*

The supply from the Hudson would be obtained by elevating the water by mechanical power, and therefore did not require much instrumental examination.

The Patroon's creek and the Hunger kill are elevated above the most dense part of the city, and by taking the water from near the sources of these streams, it may be delivered at the highest part without the aid of mechanical power.

Your instructions required that a present daily supply of three millions of gallons should be obtained, with the means of eventually increasing it to double that quantity.

The present population of the city may be estimated at about fifty thousand.

The rate of supply to each inhabitant which is ordinarily assumed in estimates of this kind, is thirty gallons, which is intended to provide for domestic use, for manufactories, for the extinguishment of fires, for public fountains, and for cleansing the sewers.

It is evident, therefore, that the quantity required cannot be based alone on the population, but must be influenced by the number of manufactories, by the liability to conflagration, and by the area of the city to be supplied.

In reference to all of these requirements, the city of Albany will not be likely to demand an amount of water exceeding that which has been found necessary in other cities, on which the estimate alluded to has been based.

The minimum quantity named in your instructions will be sufficient when the population is double that of the present.

About two thirds of the consumption of water will probably take place below a level of one hundred feet above tide, and the balance above that level.

In the future increase of the city these proportions will be likely to continue relatively the same.

The quality of Water from the various sources proposed.

The frequent rains which have prevailed since the surveys were commenced, have kept the waters of the streams so turbid that fair samples could not be procured for analysis. I have been furnished with several analyses which have been heretofore made, of the before named streams, which are as follows.

The first is taken from Major Douglass' Report, and is the result of examinations made by Dr. Emmons, as follows:

"The water in each bottle was transparent, limpid, and without odor or unpleasant taste; indeed, each, so far as it could be tested in this way, appeared of an excellent charac-

ter for drinking, and so nearly alike that it was difficult to distinguish them from each other. But though so nearly similar in their sensible properties, chemical tests demonstrated some differences. The test of hardness, for example, (tincture of soap,) showed number 2, (Hudson river water,) and number 3, (Patroon's creek, above the falls,) softer than number 1, (Mohawk water,) and than number 4, (Patroon's creek, below the falls.) A specimen of each being treated with a given portion of the tincture, the turbidness of numbers 1 and 4 was so great that print could not be distinguished through them, while it could be distinctly seen through numbers 2 and 3.

"By the analysis, the water of Patroon's creek, above Tivoli, (number 3,) showed, of soluble matters, per gallon, 3.12 grains; and of vegetable and organic matter, 1.60: total, 4.72.

"The same water, below the mills, near the turnpike, (number 4,) showed, of soluble matter, 4.48 grains; and of vegetable and organic matter, 1.60, (as before:) total, 6.08.

"The soluble matters are generally chlorides of lime, magnesia, etc., a little sulphate of lime, some carbonate of lime, and a trace of silex and alumine.

"The chief difference in the two specimens just given, appears to be in the proportion of carbonate of lime, the former having only a fraction of a grain in a gallon, while the latter has more than 2 grains; and this would seem to account for its greater hardness. Of the other waters, that from the Hudson river (number 2) contains, of soluble matter, per gallon, 4.48 grains; and of vegetable and organic matter, 1.84: total, 6.32. Another specimen, however, showed, of soluble matters, per gallon, 4.34 grains; and of vegetable and organic matter, 3.00: total, 7.24.

"The waters of the Mohawk (number 1) showed, of soluble matter, per gallon, 5.36 grains; and of vegetable and organic matter, 2.52: total, 7.88.

"It results, generally, that the water of the Patroon's creek, above the falls, as might be expected, from its origin in a clean, sandy region, is decidedly the softest and purest of all. That of the creek below the mills, and of the Hudson river, somewhat inferior in both respects; and the Mohawk decidedly inferior.

"Some other analyses of city waters were also furnished by Dr. Emmons, and are given for comparison:

	Grains.	Total.
"1. The pentstock water contains, of soluble matter, per gallon, ...	4.64	
And of vegetable, etc., ...	8.00	
	——	12.64
"2. A well in Lydius street, contains, soluble matter, per gallon, ...	13.12	
Vegetable and organic, ...	6.12	
	——	19.24
"3. Well at the old State House, contains, soluble matter, per gallon, ...	24.00	
Vegetable and organic, ...	12.00	
	——	36.00
"4. Well at the Exchange, contains, soluble matter, per gallon, ...	47.20	
Vegetable and organic, ...	17.48	
	——	64.68
"5. Well at the Capitol Park, contains, soluble matter, per gallon, ...	47.24	
Vegetable and organic, ...	18.28	
	——	65.52

"With regard to the action of water upon lead pipes, it appears that the hard waters are less active than those less hard. The hardest well waters above noticed, for example, scarcely produced any sensible effect upon strips of bright lead, immersed in them for several weeks, while in pure rain water,

the surface was covered with white powder in less than twenty-four hours. The Doctor is of opinion, however, that the small degree of hardness in the waters furnished, is sufficient to render their action upon lead inappreciable."

The following is taken from Mr. Perkins' Report, and is the result of an examination made by Professor Cook, as follows:

"One gallon of the Normans kill water, on being evaporated to dryness, yielded 6.80 grains of solid matter. This, on being heated to redness, lost 1.43 grains, leaving 5.37 grains of fixed solid matter.

"One gallon of Hunger kill water, on being evaporated to dryness, yielded 5 grains of solid matter. This, on being heated to redness, lost 0.64 grains, leaving 4.36 grains of fixed solid matter.

"Analysis of the Normans kill water:

Chloride and sulphate of magnesia,	1.25
Chloride and sulphate of lime,	0.57
Carbonate of lime,	3.55
Total,	5.37

Analysis of the Hunger kill water:

Chloride and sulphate of magnesia,	1.00
Chloride and sulphate of lime,	0.60
Carbonate of lime,	2.40
Silica,	0.36
Total,	4.36

"On testing them with a solution of soap in alcohol, they gave no white precipitate as hard waters do.

"These samples of water were taken, one from the Normans kill at Bunker's bridge, town of Guilderland, and the other from Batterman's mill-pond, on the Hunger kill, in the same town. They were taken on the 4th of May last, a time when the

streams were very low. Both specimens were transparent, colorless, and agreeable to the taste.

"The water of the Hunger-kill is remarkable for its coldness, its temperature at this time (July 20th) being 57°. Both of them are used by persons living near them, for washing; and the Hunger kill is also used for culinary purposes and for drinking.

"The qualities of these waters may be better judged of by comparing their analyses with those of the waters furnished to the city of New York, Philadelphia and Boston, as given in Professor Silliman's Report to the Commissioners of the Boston Water Works:

	No. grains solid matter in 1 gallon.	Loss by heating to redness, in grains.	No. grains fixed solid matter.
Croton.....	10.93	4.28	6.65
Schuylkill.....	5.50	1.24	4.26
Cochituate (surface).	1.85	0.63	1.22
Do. (62 ft. under do.)	3.37	1.16	2.21
Hunger kill.....	5.00	0.64	4.36
Norman's kill.....	6.80	1.43	5.37

"The waters used in the above-named cities are all considered of excellent quality, and it will be noticed that those found in this vicinity appear very favorably in the comparison."

The above analyses indicate the following order in the purity of the water:

1. Patroon's Creek above Tivoli..... 4.72
2. Hunger kill..... 5.00
3. Patroon's creek, below mills 6.08
4. Hudson river..... 6.32 and 7.24
5. Norman's kill..... 6.80
6. Mohawk river 7.88

The following analyses have been made by Professor Brande, of the waters in and near London:

	Grains of solid matter in one imperial gallon.
Thames, at Greenwich	27.9
" London	28.0
" Westminster	24.6
" Brentford	19.2
New River	19.2
Lea "	23.7
Long Acre, deep well, brewery	56.8
Royal Mint	37.8
Hampstead Water Works	40.0
Lambeth Brewery	50.0
" Shallow-well	110.0
Old street Brewery, deep well	38.9
Trafalgar Square Fountains, deep well	68.9
Well in St. Paul's Churchyard	75.0
" St. Giles', Holborn	105.0
Artesian well, at Grenelle, Paris	9.86

The city of London is chiefly supplied with water pumped up from the Thames; of the nine companies which furnish the supply, six obtain it from the Thames.

This has been for many years a source of great complaint, but the fact that they have used this water for so many years, especially when it is remembered, that it is a tidal river, and consequently the chief part of the sewerage of that immense city is carried back and forth by the movement of the tide, and must be taken up in large quantities by the pumps, is evidence that there is more of popular prejudice than real objection to the use of river water. It is purified by filters before being used.

Other large cities in Great Britain and on the continent, are supplied from river water of vastly inferior quality to that of

the Hudson, against the use of which no objection has been made.

The analysis shows the water of the Patroon's creek to be somewhat more pure than the Hunger kill.

The whole character of the soil which sheds its waters into the Hunger kill, Kaikout, Blockhouse and Patroon's creek, is essentially the same; the character of the waters from these streams, must, therefore, be nearly identical.

And as this soil is covered by a very scanty vegetation and is very porous, but little vegetable matter can be taken into solution by the rain water falling on it and passing off to the streams.

The sand also is quite free from mineral deposit, and therefore the waters must show by analysis, as they do, remarkable purity.

The temperature of the water in these streams has been taken frequently during the months of June and July, and is as follows:

	Degrees.
Patroon's creek, near Tivoli	61 to 63
" " Junction of Railroad branch	56 to 62
" " branches in woods	56 to 62
Hunger kill, in Batterman's pond	65 to 67
" " woods	55
Kaikout, in open field	71
" in woods	55
Blockhouse, in open field	71
" in woods	57
Hudson river, (6 feet below surface)	75 to 77
The springs which issue from the banks along the sand streams are generally from	51 to 53

It results, therefore, that the waters of the Patroon's creek and the Blockhouse Kaikout and Hunger kills possess the qualities desired for domestic uses, and in these respects are superior to those from the Hudson.

The quantity of Water which can be obtained from the different sources proposed.

The Hudson river furnishes an abundant source, and the supply will depend on the extent of the mechanical power provided for elevating it to the proper height for distribution.

Gauges of the Patroon's creek, Hunger kill and the Kaikout and Blockhouse, have been heretofore made by several persons, as follows:

	Galls. per day.
Of the Patroon's creek, by Mr. Carpenter, taken near Tivoli falls, amounting to,	6,507,307
Of the Patroon's creek, near the Junction of the branch railroad, stated by the late Water Commissioners, at,	3,800,836
Another by Mr. Tracy, supposed to be at the same place, at,	2,405,600
Of the Hunger kill, by Mr. Many, (east branch,)	2,952,593
" " (west branch,)	5,350,986
" by Mr. Perkins, (east branch,)	2,026,000
" " (west branch,)	5,058,000
Of the Kaikout, at the turnpike,	1,311,000
Blockhouse, at the turnpike,	701,000
Of the Normans kill, at French's mill,	8,218,000

Some of these gauges are stated to be, and the others are supposed to be the result of one or two trials only.

It is not believed to be possible to ascertain the minimum flow of a stream, without very careful examinations continued over a considerable period of time. This is more necessary, when the rain falls on an extended area of flat and very porous soil, through which it is evident it must flow slowly into the streams.

The influence of a storm would in such a case increase the flow of the stream, almost imperceptibly, (unless carefully examined,) for some time after its occurrence.

Sluices have been inserted in the Patroon's creek, in the Blockhouse, Kaikout, and the two branches of the Hunger kill, for the purpose of guaging the water flowing in these streams.

The Patroon's creek has been guaged daily since the 24th of May, at the culvert near the Railroad Junction, and since the 19th of June, at a point above and near Tivoli falls.

The gauging was commenced on the west branch of the Hunger kill on the 13th day of May, on the east branch on the 24th of May, on the Kaikout and Blockhouse on the 1st of June, and has been continued until the present date.

The following shows the result of the gauging:—

	Galls. per day.
*Patroon's creek above Tivoli falls, from June 19 to July 14, an average of	9,696,646
July 22d to July 30, an average of	14,341,017
Making a mean of	12,018,831
Patroon's creek at the Junction of the branch Railroad from May 22d, to June 12, average of	4,977,968
The same from June 12, to July 19, average of	5,121,792
The same from July 19, to August 1, an average of	6,146,250
Making a mean of	5,415,337
East Branch of Hunger kill, from May 24, to June 18, an average of	2,174,944
From June 18, to July 6, an average of	2,235,854
From July 6, to August 1, an average of	2,325,024
Making a mean of	2,245,274

* The heavy freshet of July 14th, broke up the sluice, and interrupted the gauging for a few days.

	Galls. per day.
West branch of Hunger kill, from May 13, to June 18, an average of	5,063,214
From June 18, to July 6, an average of	4,939,838
From July 6, to August 1, an average of	4,508,524
Making a mean of	4,837,192
Blockhouse, from June 1, to June 30, an average of	491,961
From July 1, to July 17, an average of	566,092
From July 17, to August 1, an average of	694,137
Making a mean of	584,063
NOTE.—Patroon's creek, above Tivoli falls, from July 30th to August 24th, an average of	11,660,267
Making, from June 19th to August 24th, a mean of	11,899,300
Patroon's creek, at the Junction, from July 30th to August 24th, an average of	4,979,905
Making, from May 22d to August 24th, a mean of	5,306,478
East branch of Hunger kill, from July 30th to August 24th, an average of	2,172,804
Making, from May 24th to August 24th, a mean of	2,227,156
Blockhouse, from July 30th to August 24th, an average of	562,093
Making, from June 1st to August 24th, a mean of	578,571

The observation which gave the greatest discharge on each of the streams during the above period is as follows :—

	Galls. per day.
Patroon's creek, at Tivoli, July 19	20,979,129
" Junction, "	14,421,888
East branch of Hungerkill, June 10	4,420,915
West " July 6	9,439,880
Blockhouse, July 19	2,244,153

Single trials have been taken of the gauges of several other streams which are as follows:

	Galls. per day.
Gates' creek at Railroad, May 8	3,300,000
Standford's " "	1,500,000
NOTE.—The Patroon's creek at Junction on the same day gave	5,700,000
East branch of Lych's kill, May 17	7,357,840
NOTE.—The west branch was one-third larger on that day, say	9,800,000
And about the same date the Patroon's creek, at the Junction, was discharging	6,000,000
Shaker brook, at Mill, June 12	7,500,000
Patroon's creek, same day, discharged	4,920,000
Outlet of Thompson's lake, June 19	2,600,000
East and west branches of Hunger kill, July 6, in one hour, at the rate of	27,000,000
On the same day the discharge was, for all day	11,908,156
Gates' creek, June 26, taken by Mr. Perkins	1,036,873
Stamford's creek, June 26, taken by Mr. Perkins	137,655
North-east branch Lych's kill, June 25, taken by Mr. Perkins	970,717
On the same day the Patroon's creek at Junction discharged	4,966,792

The value of a stream of water for the purposes under consideration, does not depend upon its minimum flow, unless that exceeds the quantity which is required, but may be greatly increased in volume, if its surplus waters, during the wet seasons and heavy rains, be stored in artificial reservoirs, and served out as required for use.

It therefore becomes important in the investigation of the subject, to ascertain the whole quantity of water which can be thus collected during the whole year.

This evidently depends upon the area of the country which sheds its water into the stream in question.

Under like circumstances, the quantity which passes off through the streams is proportional to the area of the water shed.

In ascertaining the quantity which may be collected in a particular district, the following elements are necessary:

The area of the water shed.

The minimum fall of water in any one year.

The character of the soil, and the slopes of the ground with reference to loss by evaporation and absorption. And,

The facility for constructing retentive reservoirs.

Surveys have been made of the area of ground which sheds its waters into the streams, as follows:

	Acres.
Into the Patroon's creek, at half a mile above the Junction of the branch Railroad, amounting to.....	1,935
Into the same stream, at the Junction, ...	2,025
Into the Gates creek, above the proposed dam,.....	1,193
Into the Patroon's creek, at the Tivoli dam,.....	8,455
Into the Kaikout, above the proposed dam,.....	397
Into the east branch of the Hunger kill,.....	856
" west " "	3,800

Records have been kept at the Albany Academy of the fall of water at that place for the last forty years. The mean for the last twenty-four years is 40.92 inches per annum. The least fall was in 1834, and was 32.45 inches.

Professor Cook has politely furnished me with the Reports of the fall of water in each month, for each year, from 1836 to the present date, which are as follows:

TABLE,

Of the Quantity of Rain and Snow which fell in each month of the years named, at the Academy, at Albany, in inches.

Month.	1836.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	Mean.*
Jan.	7.30	2.25	2.25	2.17	2.16	4.19	1.15	2.13	1.89	3.93	3.03	2.54	2.07	0.76	2.81	2.70
Feb.	4.39	2.77	2.20	1.57	2.44	2.12	3.21	3.21	1.61	2.94	3.72	3.80	2.37	1.25	2.16	2.69
March,	1.70	3.47	2.09	1.52	3.99	3.15	2.69	7.37	2.82	3.75	3.34	4.39	2.78	2.86	1.96	3.28
April,	2.30	1.63	1.53	4.75	5.23	3.75	4.90	4.25	0.92	2.38	0.74	2.79	1.08	0.75	3.76	2.64
May,	3.86	7.34	7.45	3.83	2.28	2.24	1.44	2.07	5.94	3.92	3.45	2.25	8.11	5.40	6.01	4.26
June,	5.67	5.06	7.60	5.12	3.47	2.10	4.44	5.54	4.60	3.42	3.84	5.06	4.72	4.45	5.72	4.65
July,	2.48	4.38	1.72	5.77	3.40	1.56	3.42	4.42	3.29	2.51	5.58	5.47	7.92	0.70	8.57	3.75
Aug.	2.25	3.96	4.91	1.24	4.77	4.27	4.15	6.05	2.58	2.42	2.07	1.94	3.79	4.83		3.52
Sept.	3.49	1.95	4.46	2.75	5.76	5.65	6.40	2.19	2.23	3.87	2.22	3.56	3.22	1.06		3.49
Oct.	3.99	3.59	3.32	1.35	4.81	1.34	4.22	5.72	3.61	2.56	3.53	3.08	4 31	8.04		3.82
Nov.	3.31	2.14	3.55	2.95	3.13	3.34	4.76	3.04	2.47	4.42	5.37	2.19	2.61	4.51		3.41
Dec.	3.91	2.63	0.95	5.09	2.94	4.14	5.21	2.36	3.04	3.33	2.96	4.31	5.24	2.11		3.44
Total,	44.65	41.17	42.03	38.11	44.38	37.85	45.99	48.35	35.00	39.45	39.85	41.38	48.22	36.72	30.99	41.65

* 1850 not included.

The rains which have fallen in the months of April, May, June and July of the present year, are as follows:

Month.	Day.	Fall of Rain: In.	Month.	Day.	Fall: Inches.	Month.	Day.	Fall: Inches.	Month.	Day.	Fall: Inches.
Ap'l	3, 4 & 5	1.21	May	4, 5 & 6	1.22	June	2	0.11	July	1	0.25
	11 & 12	0.40		6	0.54		3	0.23		3	0.97
	13	0.32		8 & 9	0.58		8	0.12		3	0.02
	14	0.06		14	0.02		10	0.67		4	0.23
	16	0.02		15 & 16	1.34		20	2.00		6	2.61
	22 & 23	0.67		17	0.23		20	0.49		15	0.33
	27	0.20		20	0.87		23	0.42		19	2.76
	28 & 29	0.88		23	0.13		23	0.02		20	0.28
				24	0.04		28	0.41		28	0.52
				26	0.15		29	0.75		29	0.08
				26 & 27	0.54		29	0.50		30	0.52
				30	0.12						
				31	0.23						
	Total,	3.76			6.01			5.72			8.57

A table has been prepared which shows the water passing through each sluice, each day, since the guaging was commenced, and also the fall of water on each day, as given above.

The soil is uniformly a porous sand, which undoubtedly overlays the clay which is seen to crop out along the banks of the Hudson and Mohawk rivers, and Normans kill, which surround three sides of the plain.

In many of the ravines through the district in question, clay is found, of the same character as that which shows itself on the slopes of the rivers before mentioned.

From circumstances which have been ascertained, it is probable that this clay undulates somewhat like the surface of the ground, though probably not to the same extent.

Such a soil is peculiarly well adapted to the collection of a large portion of the falling water, as its open, porous character allows the falling water to pass beneath the surface rapidly,

before much evaporation takes place, and then allows it to pass through freely to the streams.

On the other hand, other features of the country in question are quite unfavorable to the collection of a large portion of the falling water, viz: The flat slopes of the ground descending towards the streams, and especially the extent of large basins at the sources of the streams, surrounded by hills, are either underlaid by the clay, or an impervious soil, formed by the decomposition of vegetable matter. The rims of these basins are elevated sufficient to retain the water in them to a certain depth, a large portion of which will pass off by evaporation, and be lost for the purposes now under investigation.

These basins are, however, shallow, rarely over three feet, and generally not exceeding one foot in depth.

After they are filled to the height of the water-tight rims, the balance of the water which drains into them, passes over and descends to the streams.

The extent of the area of these basins is very considerable, and, as at a future day the supply may require to be increased, an easy method, of preventing this loss, will be by cutting through these impervious barriers, and allowing the water, which is now retained, to shed off rapidly into the streams.

Ditches to accomplish this purpose can be dug at a trifling expense, and would amply repay the owners of the land, by reclaiming for the purposes of cultivation large areas of the most fertile land of the district.*

John B. Jervis, Esq., an Engineer of high reputation, and well known to your Board, has investigated the question of the ratio of supply which may be obtained from the falling water; and under his direction, the undersigned made the first extensive experiments to determine this question.

* It may be remarked in this connection, that these basins are found more extensively within the drainage of the Patroon's creek, and especially of Gates' creek, than of the Hunger kill and the other streams; and therefore, that the Hunger kill will probably give a larger ratio than the Patroon's creek. The difference however is small, and has not been taken into the estimates.

These experiments were made to determine the dimensions of the reservoirs which were proposed for supplying the Chenango canal with water.

Appended is a detailed account of these experiments, which saves any further description of them in this place.

It will be seen, that in that district of the country, nearly one-half of the falling water in one case, and about two-thirds in another, passed off through the streams, and could have been collected in reservoirs, as was done, after they were constructed.

In some experiments made by order of the Water Commissioners of the city of Boston, the drainage of Long pond, equal to 11,400 acres, gave a ratio of forty-four per cent of the falling water, in 1837 and also in 1838, which passed off through the streams.

Other experiments have been made on large districts in this State, which gave a ratio of about fifty per cent.

In some estimates, prepared by Mr. Jervis for the Boston water-works, he assumes a ratio of sixty per cent.

In a recent publication, I find it stated that the mean of the years 1836 to 1843, of the fall of water in a certain district in England, was 26.614 inches, and the quantity evaporated over the same district, was 15.32 inches—being sixty per cent, and leaving forty per cent to pass off through the streams.

It may be supposed that the humid atmosphere attributed to that country, would retard evaporation; but the following comparison of the evaporation from the surface of water, in Great Britain, France, and this country, shows it to be nearly the same.

Evaporation is mainly dependent upon the temperature—heat promoting the process, and cold retarding it—as will be seen by the annexed tables of the evaporation, and the average temperature in each month of the year.

Evaporation from the surface of water, is much influenced by the prevalence of winds, which bring constantly a new

and drier atmosphere in contact with the water, and thus absorbs it more freely.

The following is the comparison above alluded to, being the evaporation from the surface of water, observed by different persons, at different places, for a term of years:

			Years.	Inches.
At Liverpool, by Mr.		Dobson,	3	36.77
Kendall,	"	Dalton,	3	25.75
Tottingham,	"	Howard,	8½	30.47
London,	"	Daniel,	3	23.98
Glasgow,	"	Colquhan,	2	32.41
The mean of these is				29.88

Dr. Thompson says the mean for Great Britain is	32.00
The evaporation in Paris is stated at	34.00
Dr. Hale, of Boston, has ascertained that the mean of several years, at that place, was	31.72
Mr. Coffin, of Ogdensburgh, N. Y., has stated that the evaporation at that place, in 1838, was	49.36
But this quantity does not correspond with several other authors, who state it in several districts in the United States at from 30 to 36 inches—mean	33.00

The peculiar nature of the ground on which the water falls, at the sources of the streams near Albany, rendered it indispensable that experiments should be made in this case, to determine the ratio between the fall and drainage.

Accordingly the guages were commenced with a view to ascertain this ratio.

It was not expected, however, that these experiments would be continued for a whole year before the Board would decide on the souree; but two or three months continuance would afford considerable information on the subject, and by comparing the results thus obtained with similar results of other experiments, a generally correct idea might be formed.

Besides, although it might be necessary to commence and indeed complete the works in question, before a year's result could be obtained, yet the information thus acquired would be of great service in determining upon the enlargement of the works when the increase of population should demand it.

They might also be used even before the work was completed, to modify the dimensions of the retentive reservoirs.

The guages have been continued on the Patroon's creek near the Junction for 71 days, (up to July 30) during which period 46,652,600 cubic feet of water have passed off.

The fall of rain during the same period has been 15½ inches, which on an area of 2,025 acres would amount to 113,936,625 cubic feet.

This gives a ratio of 42 per cent.

The guaging has been continued for too short a period to ascertain how long the water, falling on the earth, would be in reaching the stream. The flat slopes of the ground would probably delay the passage of the water more than a month; and as a much larger quantity of rain fell in July than in the month preceding the commencement of the gauging, the ratio above obtained is evidently too small. If the experiment had been continued for a whole year, it is probable that the ratio would have been fifty per cent; yet in the present stage of the question, it will be taken at forty-five per cent of the fall.

The average fall of water for the last twenty-four years is 40.92 inches, forty-five per cent of which gives 18.4 inches as the amount which would flow through the streams.

The least fall was in the year 1834, and was 32.45 inches.

Forty-five per cent of this is 14.6 inches.

	Acres.
The area of the drainage into the Patroon's creek above the Junction is.....	2,025
and of the Gates creek is.....	1,193
making together.....	3,218

	Gallons.
Sixteen inches of water per annum over this surface would give an average daily supply of.....	3,994,052
The drainage of the Patroon's creek above the Tivoli dam is 8,455 acres, and the same depth over this surface would give an average daily supply of.....	10,507,480
The drainage of the Kaikout above the proposed dam is 397 acres, and the same depth over this surface would give an average daily supply of..	493,373
The drainage of the east branch of the Hunger kill is 865 acres, which would give an average daily supply of.....	1,074,984
The drainage of the west branch of the Hunger kill is 3,800 acres, which would give an average daily supply of.....	4,722,464
By a comparison of the gauge of the Blockhouse with the Patroon's creek, it is estimated that it will give an average daily supply of.....	446,000

The guages of these streams which have been heretofore made, show a greater amount of water at what was supposed to be the minimum flow of the last year than these results indicate.

By referring to the table on page 17, it will be seen that the months of May and June, 1849, furnished nearly forty per cent of the whole fall of water for the year.

One of the guages in question was made in May, and the other so early in July, that it was probably much affected by the fall of water in June; hence they were above the minimum flow.

From this examination, it appears that the minimum supply, of three millions of gallons, can be obtained from the Patroon's creek at the Junction, including the Gates' cree and that the maximum supply of six millions of gallons can be obtained from the Patroon's creek near Tivoli falls.

The minimum supply being taken from Patroon's creek near the Junction, the maximum can be obtained by turning the waters of the Lych's kill and Shaker brook into the head waters of the Patroon's creek.

The Blockhouse, Kaikout, and the east branch of the Hunger kill, will, with some drainage which may be turned into them, together, furnish the minimum supply, and the maximum may be obtained by adding thereto the west branch of the Hunger kill.

The table on page 27, has been made for the purpose of determining the size of the retentive reservoirs on the Patroon's and the Gates' creek, and the results thus obtained may be applied to the other streams, as a sufficiently accurate approximation for the present purpose.

The expenditure of water during each month would be made up of the following items:

1st. The evaporation from the surface of the reservoir.

2d. The leakage and waste from the works; and

3d. The consumption in the city.

Mr. Coffin, of Ogdensburgh, made experiments of the amount of evaporation which took place each month of the year 1838, which gave for the whole year, 49.36 inches.

This exceeds any other experiments which I have seen, by nearly one-third, but it will be taken in constructing the following table, in which the depth of evaporation per month, as given by Mr. Coffin, is applied to an area of fifty acres:

TABLE.

MONTHS.	Depth of Evaporation per month, in inches.	Amount of Evaporation per month in gallons, on fifty acres.	Estimated consumption for all city uses, including waste in distribution, in gall's. being an average of 3,000,000 per day.	Loss by leakage and waste.	Total loss and consumption per month.
January,	1.65	2,335,905	64,000,000	21,325,600	87,661,505
February,	0.82	1,160,874	58,000,000	"	80,486,474
March,	2.07	2,930,499	72,000,000	"	96,256,099
April,	1.62	2,293,434	90,000,000	"	113,619,034
May,	7.10	10,051,470	94,000,000	"	125,377,070
June,	6.74	9,541,818	105,000,000	"	135,867,418
July,	7.79	11,028,303	124,000,000	"	156,353,903
August,	5.41	7,658,937	124,000,000	"	152,984,537
September,	7.40	10,476,180	120,000,000	"	151,801,780
October,	3.95	5,592,015	104,000,000	"	130,917,615
November,	3.66	5,181,462	78,000,000	"	104,507,062
December,	1.15	1.628,055	62,000,000	"	84,953,655
Total,	49.36	69,878,952	1095,000,000	255,907,200	1420,786,152

The soil upon which the reservoirs on the Patroon's and Gates' creek would be constructed are very unfavorable for retaining water.

As an approximation, the loss from this cause will be taken at eight feet depth per annum, which would give per month, 11,325,600 gallons, on an area of fifty acres.

The soil at the Blockhouse and Kaikout dams is the same, and the loss would therefore be the same, on an equal area.

At the Hunger kill the soil is very favorable for the retention of the water, and the loss would be less under the same head; but the depth of water in the dams would be so much greater, that the loss by leakage would be nearly the same, on the same area.

The soil at the Tivoli reservoir is likewise very favorable, and the loss by leakage will be taken at six feet.

The average supply of three millions of gallons includes the waste in the distribution, and the supply for public fountains and hydrants, and for the extinguishment of fires, which will be alike for every plan, and will probably be increased in the same proportion as the consumption for domestic uses.

The loss at the waste weirs may be set down at ten per cent of the supply, or say ten millions of gallons per month.

The minimum which has been determined on (three millions) is an average daily supply of that amount during the year.

In the city of Philadelphia the expenditure during the months of July, August, and September, for four years was nearly one-third more than the average for each month.

In the table on page 25, this expenditure for each month is estimated to provide for unequal consumption at different seasons of the year.

In the table on page 27, the fall for each month is taken at the mean of the years 1836 to 1848, and the quantity which would have run into the Patroon's creek reservoirs is taken at forty-five per cent of the fall.

The expenditure for each month, including the evaporation, leakage, waste, and consumption, is taken from the table on page 25, and the fifth column shows the excess or deficiency of the supply for each month.

The next column shows the aggregate of the excess of the supply which must be stored in the reservoir for subsequent use.

The largest aggregate of accumulation occurs in the month of June, and amounts to 21,869,138 gallons.

TABLE—Showing the amounts of water which would have been collected, expended and accumulated in and from the reservoir, with the mean of the fall for the last fourteen years.

Month.	Forty-five per cent of the mean fall for 14 years: In inches.	Amount which would have run into a reservoir draining 3200 acres: In gallons.	Amount which would have been lost and consumed: In gallons.	Difference between the supply and expenditure: In gallons.	Accumulation which would have been required to be stored in the reservoir: In gallons.*
January, ...	1.215	110,226,015	87,661,505	22,564,510	137,737,699
February,.....	1.210	109,817,770	80,486,474	29,331,296	167,068,995
March,.....	1.476	133,904,196	96,256,099	37,648,097	204,717,092
April,.....	1.188	107,776,548	113,619,034	5,842,486	198,874,606
May, ...	1.917	173,912,157	125,377,070	48,535,087	247,409,693
June, ...	2.092	189,833,693	135,867,418	53,966,275	301,375,968
July, ...	1.687	153,091,688	156,353,903	3,262,215	298,113,753
August, ...	1.584	143,702,064	152,984,537	9,282,473	288,831,280
September, ...	1.570	142,477,330	151,801,780	9,324,450	279,506,830
October,.....	1.719	155,949,399	130,917,615	25,031,784	25,031,784
November,....	1.534	139,166,014	104,507,062	34,658,952	59,690,736
December,....	1.548	140,436,108	84,953,655	55,482,453	115,173,189
Total,.....	18.742	1700,292,982	1420,786,152	279,506,830	

* The amount of water which would have run into the reservoir, for the whole year, exceeds the quantity which is estimated to be required to provide for the loss and consumption during the whole year, by 279,506,830 gallons. It would not have been necessary to retain this excess, and it might therefore have been wasted, when the reservoir was full, and should therefore be deducted from the accumulation given in the last column of the above table. The greatest accumulation occurred in the month of June; and if the surplus of the year be deducted, it would leave 21,869,138 gallons which would be required to be stored.

Although the fall of water each year is somewhat uniform, (the least fall being only twenty per cent less than the average) yet there is a great difference in the amount at various seasons of the several years.

It therefore becomes necessary to apply the same method of computation to each year to ascertain the greatest surplus which will be required to be stored.

The accumulation which would have been necessary to store in each of the years, is as follows:

	Gallons.		Gallons.
In 1836....	125,000,000	1843....	40,000,000
1837....	73,000,000	1844....	157,000,000
1838....	93,000,000	1845....	125,000,000
1839....	127,000,000	1846....	129,000,000
1840....	43,000,000	1847....	100,000,000
1841....	175,000,000	1848....	70,000,000
1842....	36,000,000	1849....	196,000,000

From these results it appears that a reservoir should be provided of sufficient capacity to retain two hundred millions of gallons.

Reservoirs should be provided on the Blockhouse, Kaikout, and east branch of the Hungerkill, equal in capacity to those on the Patroon's and Gates' creeks.

The minimum flow of the Patroon's creek at Tivoli being more than double the quantity required for present use, therefore the question of the capacity of the reservoir at that place need not be entered into in this branch of the subject.

The examinations of the several plans have shown that retentive reservoirs of sufficient capacity to retain the surplus waters on each stream can be found.

The several plans which have been examined will now be described in the following order:

1st. By elevating the water from the Hudson river by mechanical power.

2d. By delivering the water from the Patroon's creek by gravitation.

3d. From the Hungerkill and the intermediate streams also by gravitation.

4th. By supplying the lower service of the city from the Patroon's creek by gravitation, and the upper service by elevating the water from the same place by mechanical power.

I. *From the Hudson river.*

The plan proposed by Mr. Cushman contemplated taking the water from the river near the mouth of the Patroon's creek, and elevating it two hundred and sixty feet to a reservoir located on the north bank of the Patroon's creek, or one on the south bank between the creek and Van Woert street.

The plan proposed by Major Douglas contemplated obtaining the supply from the river opposite the foot of Colonie street, the location of the engine and pumps at Jackson street to elevate the water one hundred and seventy feet to a reservoir near the corners of Colonie, Ten Broeck and Swan streets, and a store reservoir at the head of Van Woert street on the same level.

He also proposed to supply the upper portion of the city by another engine and pumps, to elevate the water from the reservoir just named to another reservoir at the head of Lumber street.

The plan proposed by Mr. Carpenter contemplated a location of the engine and pumps at the corner of Water and Quackenbush streets, and to extend the supply main under the basin to a chamber situated in the pier, into which the water would flow from the channel outside.

The rising main would extend from the pumps, on the line of Quackenbush and Patroon streets, to a lower reservoir located at the corner of Lark, and an upper reservoir located at the corner of Robin street.

The lower reservoir would be one hundred and fifty-five feet above tide, and the upper one two hundred and forty-five feet above tide.

The general plan on which the annexed estimates are based, is essentially the same as that presented in the report of Mr. Carpenter.

The chamber for receiving the supply from the river will occupy one of the lots on the pier, and will require the removal of the wood work to a depth sufficient to establish the foundations for the chamber and coffers for constructing the work.

The supply pipes must be carried from thence to the pump well, sufficiently beneath the channel of the basin to allow them to be protected by masonry. This will require the construction of coffer dams in sections to prevent interruption to the navigation.

The pump well will be located on the main shore, and over it will be placed the pumps and steam engines.

It is proposed to locate the lower reservoir in the ravine on the north side of Patroon, between Knox and Dove streets, with the surface of the water elevated one hundred and fifty-six feet above low water, and with a depth of thirty feet.

The rising main, from the pumps to this reservoir, is proposed to be made thirty inches in diameter, and from thence to the upper reservoir twenty inches in diameter.

The upper reservoir should be located near the corner of Robin and Patroon streets, and as far east as possible to avoid extra length in the rising main.

The Engine, Pumps, and Mains.

The steam engine is peculiarly adapted to the elevation of water by reciprocating pumps; indeed the first practical use of the power of steam was its application to raising water, and to this day its greatest effect has been attained in its use for this purpose.

The Cornish Pumping Engines have been regarded by mechanics as the most perfect structures which have been designed by modern Engineers. Indeed they have been copied and applied to other works, where the peculiar circumstances of their arrangement were quite inapplicable, although their economy and effect have been quite remarkable.

Mr. Wicksted, the Engineer of the East London Water Works, in 1843 took down a large and expensive Boulton and Watt Engine, and substituted one of the Cornish Engines, for that Company's works, which was operated with one-half of the previous expense.

The duty performed by each of the Pumping Engines at the mines in Cornwall has been kept since 1822, and has led to the most careful examination of every means of reducing the expense of working them.

Other plans of Pumping Engines have been designed, some of which rival the Cornish Engines. Among these, however, the gigantic engines erected in 1843 to drain the Harlaem Mer. in Holland, are the most celebrated.

Many of the cities in the United States are supplied by water elevated by Pumping Engines; but these do not compare favorably with similar works erected in Great Britain and on the Continent.

A table has been prepared which shows the duty performed by, and other memoranda relating to the subject, of some of the most approved engines erected abroad and in this country, and is given in a subsequent part of this Report.

The Cornish Engine may be generally described as a vertical, condensing, beam engine with a large cylinder intended

to use the expansive force of the steam to its most useful extent, with pumps driven by a direct connection from the engine beam.

The great depth of the mines, require plunger rods of great length and weight, and this circumstance is made available by using the power of the engine mainly to elevate the rods, which in their descent force up a corresponding weight of water.

When they are too heavy or too light to elevate the quantity of water required, they are adjusted with weights, added to the beam.

From the examination which has been given to the subject, a steam engine constructed nearly after the approved form of the Cornish Engine, and a plunger pump attached to each end of the arm of the engine beam, would be recommended.

In many of the Water Works in England, situated similarly to the one under consideration, the water is elevated in a vertical standing column at the pumps and the distribution pipes are connected directly with this column.

There are several advantages connected with this plan, but it is believed that they cannot be rendered available to their full extent in this place without an expenditure that the circumstances would not warrant.

If this plan is adopted, it will be a subject for future consideration, whether a considerable portion of the lower part of the city cannot generally be supplied by means of a standing column, the effect of which would reduce the cost of elevating the water.

This plan would only furnish a supply while the engine was in operation, and means must be provided to turn on the water from the reservoir whenever the engine ceased operation from any cause.

In arranging the plan of an engine an important consideration has presented itself, viz.: whether the machinery should be duplicated to provide one for use when an accident occurs.

After the city is supplied with water on the plans now contemplated, and the old sources of supply have become dilapidated from disuse, or removed, it would be very disastrous to have the new source fail.

The large reservoirs contemplated, will provide for such a contingency to a considerable extent, but they will, when full, furnish a supply for the present population for less than a month, and an accident may happen to the machinery, when the reservoirs have been nearly exhausted by some large conflagration, or other cause.

The economy of working, would clearly indicate the propriety of having a single, instead of a double engine.

After carefully considering the subject, I am induced to the belief, that the only safety is in having a duplicate engine on hand, and ready to be used at a moment's notice, when an exigency may occur.

This engine, however, should be of power just sufficient to furnish the minimum quantity of water required; and, as it will only be used on extraordinary occasions, cheapness in construction should be regarded in preference to economy in running.

The cost of such an engine has been provided for in the estimates.

The elevation of water to so great a height as that contemplated for the upper reservoir, (two hundred and thirty-eight feet,) is unusual in works of this kind, and will require not only an extra thickness of metal in the rising mains, to resist the pressure of the water, but additional care in laying down and securing the pipes. Provision must also be made against the percussion which would be caused by the return of so long and so heavy a column of water, when the pumps cease operation, or lose their charge.

An air-chamber is always attached to such pumps, which provides for the suspension of the moving power, at the termination of each stroke, and against the shock which would be

experienced in starting the pumps with so long a column of water resting upon them.

In addition to the air-chambers, check-valves must be inserted in the pipes, at suitable intervals to break the column into short lengths, and by these means accidents will in a great measure be prevented.

It has been before stated that it is proposed to make the rising main from the pumps to the lower reservoir, thirty inches in diameter, and the one extending from the lower to the upper reservoir, twenty inches in diameter. When the engine is forcing the water into the upper reservoir, the water will be flowing through the upper main, with a velocity as much increased as the inverse ratio of the area of the two pipes.

Careful computations have been required for ascertaining the resistance to be overcome by the engine, in elevating unequal quantities of water into two reservoirs with so great a difference of elevation, and the friction of the water in passing through long rising mains.

The general results of these calculations will now be stated.

The minimum for the present supply is three millions of gallons.*

Two-thirds of the quantity above named, will be required to be delivered into the lower reservoir, and one-third into the upper reservoir.

The surface of the water in the lower reservoir will be one hundred and fifty-six feet above low water in the Hudson. The surface of the water in the upper reservoir will be two hundred and thirty-eight feet above low water.

It is true that for a great portion of the year, the water in the river is higher than the level assumed; but the greatest expenditure takes place when the water in the river is the lowest.

* The Imperial gallon contains 277.274 cubic inches; the United States standard, 231 cubic inches; and the New-York standard, 221.184 cubic inches of pure water, at its maximum density, which weigh as follows: Imperial gallon, 10 pounds; United States standard, 8.355 pounds; New-York standard, 8 pounds. A cubic foot contains 7.8125 New-York gallons. This is the measure used in calculations in reference to this work.

It is also true that the expenditure of water through the night, when the engine is not running, will reduce the level of the surface of the reservoir, and the water will not require to be elevated the full height when the engine commences; but if these reservoirs be made as large as has been suggested, the depression through the night will be too inconsiderable to enter into the calculation.

It has been found that the expenditure during the months of July, August and September, in other cities, was nearly one-third more than the average for the year, and that on particular days, a still larger quantity of water was used.

The ample size of the proposed reservoirs will obviate the difficulty in the latter case; and as the time is somewhat distant when the population of the city will require the use of the whole quantity estimated for, no immediate provision is needed to meet it.

When it becomes necessary to increase the quantity, it can easily be done by running the engine a few hours longer, which is not objectionable, as the daylight lasts longer during the months named.*

* It is proposed to run the engine only by daylight. In works of this character it is best not to require men to work through the night hours, when the circumstances will allow it otherwise. The price of night labor is, by common rule, double that of day labor; and all experience shows that the amount done in an equal time is much less.

But there is a much more forcible objection to running complicated machinery, which, from its nature, is peculiarly liable to breakage at night, when the attendants may neglect their duty, by absence, or fall asleep, without much chance of being detected, as would be the case during the hours when the population are abroad and observing.

Duty of the Engine.

To raise 2,000,000 gallons 156 feet high, and
1,000,000 " 238 "

	Raised one foot.
2,000,000 galls. lifted 156 feet, makes....	2,496,000,000 lbs.
1,000,000 " 238 "	1,904,000,000 "
Making a total of.....	4,440,000,000 "

This duty is to be done in twelve hours, which will give per minute, 6,111,111 lbs. one foot high.

The friction of 1,000,000 of gallons of water passing through a main 20 inches diameter and 8,000 feet long, in six hours, is as follows:

		1 foot high per minute.
By Hawksley's formula,	$P=\frac{Q^3L}{140D^5}$	is 733,270 lbs.
Storrow's "	$H=\frac{V^2L}{(48.53)^2D}$	is 337,500 "
Prony's "	$Q=38.116\sqrt{\frac{D^5H}{L}}$	is 335,000 "
Eytelwein & Tredgold's "	$V=\sqrt{\frac{2500DH}{50+D}}$	is 333,000 "

The friction of 2,000,000 gallons of water passing through a main 30 inches diameter, 5,000 feet long in 6 hours, is by Hawksley's formula, 462,000 lbs. 1 foot high per minute.

That a liberal provision of power may be made to overcome this friction and that, caused by the bends in the pipes, the largest result above stated will be taken, viz: 733,270 lbs. raised 1 foot high per minute.

The friction of the pumps and machinery is estimated at one-fifth of the power, which amounts to 1,222,222 lbs. raised 1 foot high per minute.

These several amounts added together give the total duty of the engine at 8,066,603 lbs. raised 1 foot high per minute.

An engine of power sufficient to perform this duty must be of the following dimensions:

Steam cylinder 58 inches diameter and 12 feet stroke of piston.

Making 10 strokes per minute, gives a velocity to the piston of 240 feet per minute.

Steam in the boiler at 30 lbs to the inch, would give on the piston an effective pressure of 20 lbs. per square inch. This being cut off at one-fourth the stroke, will give a mean effective pressure on the piston for the whole length of the stroke, of 12.1 lbs. per square inch.

The effective vacuum of 9.5 added, makes a total pressure of 21.6 lbs.

These dimensions would give a power of 8,677,599.9 lbs. raised 1 foot high per minute by the formula $\overline{(P+v)-(f+m)} \times s-\overline{nb}$.

The duplicate engine is proposed to be made horizontal, non-condensing, working steam at 70 lbs per square inch at the piston, cut off at three-fourths stroke, making 20 strokes per minute, and running 20 hours per day.

The whole duty is, as before, 4,440,000,000 lbs. raised one foot high.

This in 20 hours would give 3,666,666 lbs. 1 ft. high per m.

Friction of the pumps, machinery and pipes, as before,

1,955,492 lbs. 1 foot high per minute.

Total duty, 5,622,158 lbs. 1 foot high per minute.

To do this duty an engine with a steam cylinder of 24 inches diameter and 6 feet stroke, velocity of piston 240 feet per minute is proposed, which will give a power of 6,405,840 lbs. raised 1 foot high per minute.

The pumps of the condensing engine, are proposed to be placed one on each side of the centre of the beam, at a distance which will give them 10 feet stroke, which will make the plunger of each pump travel at the rate of 200 feet per minute.

As the discharge is due to the movement of the plunger in but one direction, the two pumps together, will discharge at the rate of 200 feet per minute.

It will be necessary to deliver into the lower reservoir 2,000,000 gallons daily, and this work is to be done, say in six hours, which is equal to 711 cubic feet per minute, which, at a velocity of 200 feet per minute, would require an area of 3.55 square feet for both pumps, equal to 1.5 feet diameter for each.

The leakage of the pumps, valves, &c. requires an addition, say of one-third, which would require the diameter of the pumps to be increased to 1.75 feet.

The pump for the duplicate engine will be required to discharge 3,000,000 gallons in 20 hours, or 320 cubic feet per minute.

The pump is to be double acting, with a direct connection from the steam cylinder, which gives it the same speed and stroke as the engine, and requires an area of 1.33 square feet. To this must be added one-third for leakage, making an area of 1.77 square feet and a diameter of 1.5 feet.

The engine and pumps must be so placed as to be above the highest freshets. That of February, 1839, rose 22 feet above the level assumed as low water.

The bed plate of the engine should be laid as high as this level.

The condensing engine above described, would continue to furnish the quantity of water required, by running it more than 12 hours, until the present population is trebled, at which time it will become necessary to build another one of the same dimensions to furnish the maximum supply, viz: 6,000,000 gallons.

The cost of running the engine and machinery is an annual charge, and in comparing the cost of the several plans, the capital which will produce a sum sufficient to pay these expenses should be charged against this plan.

This subject has attracted the attention of English Engineers for many years, and we have abundant data furnished by their experience on this subject.

For the purpose of comparing the expense of running different Pumping Engines in England and this country, the following table has been prepared of some of the most important ones in use:

TABLE.

PLACE.	DATUM.	Datum applied to the performance of the duty at Albany, viz: raising 4,440,000,000 lbs. one foot high per day, at English prices.		REMARKS.
		Cost of coal consumed. PER DAY.	Total expense, coal, oil, wages, and repairs.	
Harlaem Mer...	75,000,000 lbs., with 1 bushel of coal,.....equal to 11c.	$6.45		Mr. Dean, Engineer.
Nottingham, ...	1,000 gallons, 135 feet high, for 3d.,..... " 6c.			$163, including interest on capital and distribution.
"	1,000 " 135 " " 63-100d., " 1¼c.		$32.60	Mr. Hawksley, Engineer.
Cornwall,.....	1,000 " 100 " " ¾d..... " ¾c.		$27.72	Mr. Wicksted. "
London, ...	1,000 " 100 " " 15-100d., " 3-10c.		$13.20	Mr. Wicksted. "
Cornwall,.....	1,000,000 lbs., 1 foot high, with 1 pound coal,..11-94c.	$5.00		Mr. Farey. "
Cornwall,.....	100,000,000 " " " " 1 bushel coal, ...11c.	$4.84		Mr. Dean, max'm of 22 engines.
Est'd for Boston,	60,000,000 " " " " 1 bushel coal, ...11c.	$8.07		Estimated by Mr. Jervis.
Est'd for Boston,	52,000,000 " " " " 1 bushel coal, ...11c.	$9.00		Estimated by Mr. Wicksted.
Philadelphia,...	22,000,000 " " " " 1 bushel coal, ...11c.	$22.00		Mr. Pyolin, Engineer.
Cincinnati,.....	2,500,000 gal's, 148 feet high, 189 bushels coal,$18.90.	$27.72		Ohio prices.
N. Orleans, Est.	6,000,000 gal's, 100 feet high, 6 tons c'l, $2.50, $15,00.	$13.75		New-York prices, estimated by Mr. Allaire.
	Whole cost, wages, &c., ...$36.00.		$31.70	
St. Louis, ...	1,000,000 gal's, 136 feet high, coal .....$11.40.	$44.43		St. Louis prices.
	Whole cost, wages, &c.,.....$22.00		$85.75	St. Louis prices.
Est'd for Boston,	2,500,000 gal's, 140 feet high, 4 tons, ...$2.50, $10.00.	$10.00		English prices, Mr. Jervis.
	Whole cost, wages, &c., $13.574 per an.		$56.41	Boston prices, Mr. Jervis.

II. *From the Patroon's Creek.*

The plan which was examined by Mr. Smith, and reported on by the late Water Commissioners, was, to construct a dam across the creek, near the Junction of the branch Railroad with the old line, about four miles from the Orphan Asylum, and bring the water down the graded road bed of the Railroad (which has been abandoned,) to within three-fourths of a mile of the Asylum, where it would be discharged into a reservoir, and from thence distributed through the city.

This plan has been examined, and found to be very favorable in many respects.

Two sites for dams and reservoirs have been examined near this place. The first at the point above mentioned, and another 2,100 feet further up the stream.

Near the Junction, clay shows itself on the south bank and in the bed of the creek; but there is reason to believe that it underlays the sand at a considerable depth on the north side.

If the opinion which has heretofore been stated, is correct, viz., that the porous sand has a sub-stratum of clay beneath, it becomes indispensable that the water-tight section of the dam be extended below the surface, until it reaches this clay; or if the clay should be found to lay too deep below the surface, the interior face of the lake must be lined with clay puddle.

It may also become necessary to extend the puddle-walls a considerable distance beyond the extremities of the dam, to make a water-tight barrier as high as the water is proposed to be raised.

At the upper location, the clay developed itself more distinctly, and was found in large quantities on both sides of the creek, for a considerable height above the channel of the stream.

At the lower location, the water in the lake would be eighteen feet below the bottom of the conduit, and at the upper location, only nine feet below. This lower portion will be unavailable, and must be left in.

These depths would be unavailable for storage, and would increase the leakage from the lake.

The diminished area of the lake at the upper location would require the dam to be raised higher, and would bring the water, it is apprehended, above the level of the clay.

If this should be found to be the case, the same plan must be taken, as before mentioned, to secure it by lining.

The situation of the dam on Gates creek is the same as the others just described; but there will be only five feet depth of water below the bottom of the conduit-pipe.

Estimates have been made of the expense of introducing the waters of this creek into the dam, either at the Junction, or the upper location, at a level fifteen feet above the bottom of the main conduit, by a brick conduit, and also by iron pipes.

The latter method will be the most expensive, but is preferred for many considerations.

Specifications for performing this work at the dams, conduit and reservoirs, and their necessary appendages, have been prepared and annexed, which will save any other than a general description of the work.

The dams for the retentive reservoirs are all proposed to be made on the same general plan, as follows:

The top of the dam to be ten feet wide, and carried up eight feet above top water line. The slope on the outside to be two to one, and the same slope on the inside, to the level of the bottom of the conduit, where a base of five feet wide is made, and thence to the bottom of the dam, a slope of three to one.

In the centre of the bank, a puddle-wall eight feet wide on the top, and increasing in width four feet at each ten feet of depth.

The inner slope of the banks, to be protected by a slope-wall to the level of the bottom of the conduit, and the top and outer slope, by turfing.

A drain-pipe, to be inserted at the bottom of the bank, to draw off the whole of the water, whenever occasion requires it.

A gate-chamber, to be built in the dam at the entrance of the conduit, and a waste-weir at some suitable place.

The area covered by the lake, and also to a level five feet above, to be chopped and cleared from all vegetable matter.

The conduit will commence at the Gate chamber, and if it is determined to build the upper dam, it will follow along the north bank of the creek for a distance of 2,000 feet until the line intersects the Mohawk and Hudson Railroad just above the culvert, and near by where the conduit would commence, if the lower location of the dam should be used instead of the upper one.

Thence it will follow along side of the embankment of the Railroad, and be built upon it, if the Company makes no objections, which it is believed they will not, as the works will not interfere with their road, but will strengthen their embankment.

The culvert over the Patroon's creek will require to be lengthened thirty feet.

Below this point, the line follows the old Railroad bed, (which has been abandoned some years,) for a distance of eight thousand and one hundred feet, to near the west line of the Buel farm.

At the upper end of this distance, the Railroad bed is about fifteen feet above the grade of the conduit; and wherever the ground on the south side falls off, below the level of the Railroad, the line of the conduit is laid along the slope of the bank, to avoid unnecessary excavations.

At the lower end of this distance, the grade of the conduit is six feet below the Railroad bed.

From the Buel farm, the line leaves the Railroad bed, and follows along the base of a sand ridge running nearly east, to a point a little east of the Two-mile house.

Thence, cutting through a spur of this ridge, at the greatest depth twenty-six feet, it continues and crosses the Schenectada turnpike at the head of Patroon street.

From this point, two lines have been run: the first curves into the line of Patroon street, near its intersection with the turnpike; and the brick conduit terminates in a gate-chamber, from which the water will be conducted to the reservoir at the corner of Perry and Patroon streets, by an iron pipe twenty-four inches in diameter.

By the other line, the brick conduit will be continued along the sand ridge north of Patroon street, for a distance of six hundred feet, and thence nearly parallel to that street, to a reservoir at the northwest corner of Ontario and Patroon streets.

The size and plan of the Conduit.

In the Report which Mr. Perkins made on the Hunger kill project, he proposed to make the conduit in the form of an egg-shaped oval, the two diameters being four, and five and a half feet.

These dimensions, with one foot slope to the mile, and filled three feet and ten inches deep, will give a discharge of over eleven millions of gallons daily; and with six inches slope to the mile, over six and a half millions; and if run full, of twelve millions of gallons daily.

An oval conduit, with diameters of three, and four feet, and one foot slope to the mile, will discharge, when full, eight millions; and when the water is three and a half feet deep, seven millions of gallons per day.

The comparative expense between the two conduits, will be as the areas of the rings of brick (eight inches thick,) or as 1 to 1.3.

The quantity which would be delivered by the two conduits, when running full, the large one with six inches and the small one, with one foot descent to the mile, would be as 1 to 1.43.

With the same fall in each, the proportion would be nearly as the areas, or as 1 to 1.83.

The small conduit, including the grading, will cost from $30,000 to $40,000 less than the large one.

It will be seen that the large conduit, with a fall of six inches to the mile, and the small conduit with twelve inches, will each discharge the maximum quantity required, without filling up the whole area.

There is no doubt that the conduit would stand a head which would double this discharge, although such an arrangement would not be recommended.

From the above examination, it appears that it is unnecessary to construct the larger conduit, and give it the greater fall; and though the advantage of an extra head of two feet in the distributing reservoir is duly appreciated, yet, after due reflection, it is recommended that this advantage be waived, and that a conduit be built of the smaller dimensions.

It may be proper to remark, that an extra height would facilitate the interior examination that will be frequently required for the first year or two after it is finished, and henceforth annually.

It will be a subject for future consideration, whether the form of the conduit shall be changed, so as to increase its vertical height and diminish its width, which may be done without increasing its cost.

The estimates have been based on a conduit built of two courses of brick masonry, together eight inches thick, laid in hydraulic cement, with interior diameters of three and four feet, and generally resting on a foundation of concrete and rubble masonry.

The inclination to be one hundredth part of a foot in fifty feet, equal to one and fifty-six thousandths feet per mile.

Waste-weirs and ventilators are provided for, at intervals of about one mile.

The most favorable location for the upper receiving reservoir, is found at the corner of Ontario and Patroon streets.

The estimates have been made of the cost of a reservoir which will cover, with the base of the embankment, six hundred feet square, and also one which will cover a rectangle six hundred by eight hundred feet.

The smaller one, with ten feet depth of water, will contain 18,000,000 gallons, and with 13 feet depth, 24,000,000 gallons.

The larger one with 10 feet depth will contain 26,000,000 gallons, and with 13 feet depth, 34,000,000.

The reservoir at the corner of Perry and Patroon streets will cover an area of 523 by 633 feet, with 10 feet depth of water will contain 15,000,000 gallons, and with 13 feet depth 20,000,000 gallons; by excavating it to a depth of 12 feet below the level of the bottom of the conduit, the capacity will be increased to 18,000,000 gallons, and with 15 feet depth, (the upper three feet being above the bottom of the conduit,) it will contain 20,000,000 gallons.

By building walls of masonry six feet high around the base, and cutting off the slopes of the embankment, the capacity will be increased 2,000,000 gallons.

To obtain a reservoir of the size last mentioned, it will be necessary to close up Perry street.

Estimates of the cost of all of these plans have been prepared.

The description of the manner of constructing these receiving reservoirs, will be found in a subsequent part of the report.

The maximum supply of six millions, can be obtained by constructing a dam in the pond on the Patroon's creek below Tivoli falls, and an iron pipe from thence to the reservoir at the corner of Patroon and Lark streets.

Examinations were also made, by which it was ascertained that one of the branches of the Lishus kill could be turned

into the Patroon's creek by a ditch parallel with the railroad three miles long, the deepest cutting being 16½ feet.*

There has not been sufficient time to get a survey of the drainage of these streams, but from an examination of the country it is believed that they, with some other small streams which can also be turned in at a small expense, will afford as much water as the Patroon's creek at the Junction.

If it should ever be deemed advisable to bring these streams into the Patroon's creek, it would afford a large supply to compensate the hydraulic privileges, for the waters which would be diverted for city uses.

III. *From the Hunger Kill.*

The former surveys of this project were made by Mr. Perkins, who has been my assistant in conducting all of the present surveys.

Mr. Perkins proposed constructing a large receiving reservoir at Paige's ravine about one and one-half miles south-west from the Orphan Asylum, the surface of which when full, will be 226 feet above low water, and conducting a conduit from the upper end of this ravine to the east branch of the Hunger kill, where by dams 58 feet high on the east branch, and also on the west branch, and an open cut joining the two lakes thus made, the waters of the two branches would be turned into the conduit, the bottom of which would be ten feet below the surface of the lakes when they were full.

He also proposed small dams on the Mazeilandt, Block House and Kaikout creeks, and conduits from thence discharging into the main conduit.

The estimates have been based on the following plan:

To construct a dam on the east branch of the Hunger kill 71 feet above the bottom, with the surface of the water 9½ feet above the proposed level of the bottom of the conduit.

* Examinations were also made of the Shaker brook, by which it was ascertained that this could be brought into Gates creek, by a cut two miles long and twenty-three feet deep in the deepest place.

From the north side of the lake, to commence a conduit, which crosses Sloan's ravine, with an embankment 56 feet high, crosses the Western Turnpike near Veeder's, and the valley of the Kaikout with an embankment 61 feet high, two branches of the Blockhouse with embankments 43 and 38 feet high, and then by an easy grade to the side of the west branch of the Mazeilandt, and then bearing to the north and crossing the Western Turnpike a quarter of a mile west of McKown's and a branch of the Crommie kill near by, and following along the ridge north of the turnpike, crossing another branch of the Crommie kill near Mr. Cooper's house, with an embankment 30 feet high, and thence nearly parallel to the turnpike, to near Buel's, when by turning to the north and a cut of 52 feet deep the line intersects the old graded bed of the Mohawk and Hudson railroad, and follows down that road to its intersection with the Western Turnpike, and then follows down the graded bed of the old branch of the railroad alongside the turnpike to near the Orphan Asylum. At a point 3,800 feet west of the Asylum, the brick conduit is terminated, and the water is conducted in pipes to the receiving reservoir, which may be located either on the north or south side of the turnpike and near it.

The lake on the east branch, from a level 2 feet above the bottom of the conduit to a level $7\frac{3}{10}$ feet above, will contain 64,000,000 gallons, and by raising the water 2 feet higher it will add 31,000,000 gallons to its capacity, making 94,000,000 gallons.

This capacity will be sufficient to retain the flood waters.

At a point 2,500 feet up the valley, an eligible site for a dam was found where the bottom of the stream was 24 feet higher than at the lower site.

The capacity of the lake at a level 7.3 feet above at the upper site, would be 30,000,000 gallons, and by raising the water 10 feet higher than this level, it will give a capacity of 99,000,000 gallons above the level necessary to discharge three millions through the pipes.

If this location of the dam shall be determined upon, it would be necessary to conduct the water through pipes in the bottom of the valley, to near the site of the lower dam, in consequence of the steep sliding banks of the creek and the sinuosities of the line for a conduit.*

At the Kaikout an estimate has been made of the expense of crossing by pipes to save the expense of embankments.

The Kaikout will be dammed at a point 4,400 feet above where the conduit crosses. At this place the stream is $9\frac{6}{10}$ feet below the bottom of the conduit.

The dam will be built 43 feet above the bottom of the stream, and will contain, with the water $11\frac{1}{2}$ feet deep, fifty millions of gallons.

In consequence of the sinuosities of the line for a conduit along the sides of the ravines, it will be necessary to substitute an iron pipe to conduct the water from the dam to the conduit.

This pipe will be 16 inches in diameter, and will discharge into the conduit at a level 2 feet above the bottom.

The dam on the Blockhouse will be made by widening the embankment of the turnpike with a puddle wall 18 feet wide at top, and 30 feet at bottom, faced with gravel and a slope wall.

The bottom and sides of the stream for 150 feet up will be lined with puddle.

The dam will be 25 feet high, and the stream is 5 feet below the level of the conduit.

The available depth allowing for the head to discharge the water in the pipe, and the elevation above the bottom of the conduit will be 9 feet, which will give a capacity of 30 millions of gallons.

* The soil where these dams are proposed to be erected is very favorable, being a mixture of sand and loam or clay, as high as the water will flood the banks. Some apprehension has been expressed at the danger of these high dams giving way and producing destruction on the streams below. If they are properly constructed and ordinary care taken in watching them, it is not believed that there would be any danger of their breaking away. Dams of nearly the same height were built on the Chenango canal which have remained firm for fifteen years, except in one case, where the work was badly constructed.

It is proposed to conduct the water into the conduit, by a pipe 12 inches in diameter, for the same reasons as before mentioned at the Kaikout.

The maximum supply of six millions of gallons daily, can be obtained by constructing a dam across the west branch of the Hunger kill, of the same height as that proposed to be built across the east branch, and by connecting the two lakes by an open cut.

At a level ten feet above the bottom of the conduit, the water would flood one hundred and ten acres, and the available capacity of the reservoir would be two hundred and sixty-four millions of gallons.

There are some valuable hydraulic privileges on the Norman's kill and the streams which are proposed to be diverted to furnish the supply of water to the city.

It was proposed by Mr. Perkins to construct reservoirs to retain the surplus waters during floods, from which the mills in question could be supplied, during the dry seasons, with an amount of water equivalent to that which was diverted.

As long as the quantity of water which was required for the use of the city did not exceed three millions of gallons, the reservoir on the west branch of the Hunger kill would answer the purpose of a compensating reservoir.

When it became necessary to increase the supply for the use of the city, a compensating reservoir could be built on the Norman's kill, or at Thompson's lake, as proposed by Mr. Perkins.

No instrumental examination has been made at this time, of the two last named projects; but from an examination of the ground, and of the surveys heretofore made, it is believed that reservoirs could be made at either of these places, which would furnish, during the dry season, as much water as would be diverted for city uses.

The construction of compensating reservoirs would not however avoid all claims for damages for the water which was

diverted, but as an examination of this branch of the subject was not included in your instructions, no surveys or estimates have been made in reference to it.

In locating the conduit and the dams for the Hunger kill project, it was found necessary to take a grade for the conduit, sixteen and a half feet lower than that taken for the others.

For the purpose of comparing the cost of the several projects, it is necessary, in the Hunger kill plan, to provide for elevating the quantity of water which is required for the supply of the upper service, to the same height as in the others.

The cost of doing this, by steam power, is provided for in the estimates.

IV. *From the Patroon's Creek, near Tivoli Falls.*

The plan which is proposed for obtaining the supply from this source is, to construct a dam across the Patroon's creek, near the dam already constructed, and upon the same general plan as has been already described for the other projects.

The top water line in this reservoir would be elevated one hundred and fifty-six feet above low water, and the water would be thirty feet deep.

It would be necessary to construct an embankment parallel with the railroad on the north side of the pond, to prevent the water flowing into the railroad cut.

A stone dam would be built across the rock cutting made for the creek at the falls, and the surplus waters would be conducted through a large conduit extending from the stone dam to the foot of the lower dam.

The Reservoir would be divided in two nearly equal parts, by an earthen mound.

The wash from the hills and ravines on the south side of the reservoir would be collected in drains, and conducted into the creek below the reservoir.

The supply and drain pipes from the upper division would be laid in the bottom of the reservoir, and would be extended through the division bank and the lower dam.

The water could be distributed to the lower service directly from this reservoir, or it could be carried to the reservoir which was proposed for the other plans at the corner of Patroon and Lark streets, and the distribution made as in the other plans.

The upper service would be supplied by an engine and pumps, located on the south side of the reservoir, which would elevate the water through a main, to either of the reservoirs which have been proposed on the second plan.

The engine and pumps would be made on the same plan as those which have been described for elevating the water from the Hudson river.

The duty for the engine would be, to elevate one million of gallons of water, an average of one hundred feet high. This would require a steam cylinder of twenty-four inches diameter and six feet length of stroke, and pumps of nine inches diameter and four and one-half feet stroke.

A duplicate non-condensing engine would be required, to be used when the other engine was out of order.

When it became necessary to furnish two millions of gallons for the upper service, another engine and pumps of the same size could be constructed.

The Receiving Reservoirs.

The locations of the receiving reservoirs which have been made for each of the plans have been before stated; the same general plans are proposed for their construction.

The top of the banks will be eight feet above the ordinary top water line in the reservoir, and will be ten feet wide.

The slope on the outside will be two horizontal to one vertical, and on the inside will be one and one-half horizontal to one vertical.

The outside slope will be sodded; the top will be gravelled, and the inside slope and the bottom, will be protected by a pavement of brick laid in cement, or of stone laid without cement.

The bottom will be covered by a pavement of brick.

A course of puddling will be laid under the brick bottom, and a puddle wall will extend from the bottom puddling in the rear of the face of the banks, to a level three feet below the top.

The reservoir will be divided in two parts, by walls of masonry and puddling, through which will be extended a connecting sluice and gates. The inlet and outlet pipes will be arranged so as to supply and draw the water from either or both divisions of the reservoir.

The outside slopes of the embankments will be retained by walls of coursed rubble masonry, which will generally be built to a level six feet above the grade of the adjoining streets.

A fence will be built on top of this wall.

Some modifications of this general plan will be required in the reservoir at the corner of Patroon and Lark streets, to provide for passing Lark street through the reservoir, and for preventing the wash from the hills entering it.

TABLE:

Showing the comparative elevations, dimensions and capacity of the different Reservoirs which have been proposed for the several plans:

Location.	Level above low tide: In feet.		Area: In square feet.		Contents: In gallons.	
	Of the bottom.	Of ordinary top water.	Of land occupied.	Of ordinary surface of water.	At the ordinary depth.	Greatest capacity.
Near Tivoli Falls, ...	126	156	2,000,000	1,294,496	175,000,000	205,000,000
At Patroon and Lark streets,....	126	156	500,000	331,345	33,000,000	40,000,000
" Perry "	226	238	331,000	229,300	20,000,000	26,000,000
" Ontario "	226	238	360,000	265,668	23,000,000	29,300,000
" " " larger,	226	238	480,000	370,468	32,500,000	41,300,000
At State and Robin "	210	222	448,000	338,468	30,139,000	38,000,000
" Perry "	214	222	210,700	155,000	8,850,000	12,500,000
W. Works Co., corner of Eagle, Columbia and Steuben sts.	94	106	9,681	3,328	257,000	257,000
Do., near Railroad, ...	100	107	16,000	10,770	588,000	798,000

One of the most important matters connected with the supply of water, is, to provide an ample storage, within or near the city, for the extinguishment of extensive conflagrations, or for use, during a temporary failure of the works.

In other cities, the cost of construction has prevented the erection of as large reservoirs as are desirable for these purposes.

The contour of the ground in and about Albany, is such that large reservoirs may be constructed at a small cost.

The distributing reservoir in New-York will contain twenty millions of gallons.

The daily consumption, at this season of the year, is thirty millions of gallons. The receiving reservoir, three miles further out, will contain one hundred and fifty millions of gallons.

The distributing reservoir in Boston will contain three millions; the one in East Boston, six millions; and another in South Boston, seven and a half millions of gallons.

The receiving reservoir for the Boston works, is at Brookline, five miles from the State-house, and has an available capacity of one hundred millions of gallons.

The conduit now discharges eight millions of gallons per day, all of which is used at this season of the year.

The reservoirs in Philadelphia will contain thirty millions of gallons; and the pumps will deliver ten millions of gallons per day.

The consumption of water at this season of the year is about nine millions of gallons per day.

The reservoir at Cincinnati will contain half a million of gallons; and with two engines, they can deliver four millions of gallons at the reservoir.

The reservoirs at Greenock, in Scotland, are elevated five hundred and thirteen feet above the Clyde, and contain seven hundred millions of cubic feet of water; but the chief part of this quantity is required for manufactories, which receive their supply from the same source.

The Reservoirs at Manchester, in England, will contain three hundred millions; at Ashton, one hundred millions; and at Oldham, eighty-five millions of gallons.

Manchester contains a population of about half a million; and Ashton and Oldham each about one hundred thousand.

The finest Water-works in England are those for the supply of the town of Preston.

There are four Reservoirs. The highest one is elevated four hundred and forty-eight feet above the summit of the town, and will contain thirty millions. The next is one hundred and seventy-two feet high, and will contain seventy millions. The next is one hundred feet high, and will contain sixty millions; and the lowest reservoir, to which the others are feeders, is fifty feet above the summit of the town, and will contain seven millions of gallons.

The whole supply, when the reservoirs are full, will be one hundred and sixty-seven millions of gallons, which will supply the town for half a year. The population is about eighty thousand.*

The city of London is supplied with water chiefly from nine Companies, as follows:

The New River Company, which furnishes twelve millions of gallons daily, from Amwell and the river Lea, by two large steam engines.

The Chelsea Company, which furnishes five millions, at an elevation of one hundred and thirty-five feet, from the Thames, by one steam engine.

The Middlesex Company, which furnishes six millions, at an elevation of one hundred and twenty-two feet, from the Thames, by steam engines.

* From the service Reservoir, a fourteen inch main, two miles long, conveys the water to the town, through which sub-mains, from thirteen to three inches in diameter, are laid.

There are twenty-five miles of piping laid. Eight thousand houses, out of eleven thousand in the town, are supplied from this source.

The charge for the water for domestic purposes, is at the rate of one shilling per pound on the annual rent of the house, or ninepence per thousand gallons.

Churches, free schools and charitable institutions, and hydrants for the extinguishment of fires, are supplied free of charge.

The Grand Junction Company, which furnishes four millions, at an elevation of one hundred and fifty-two feet, from the Thames, by a steam engine.

The Lambeth and Southwark Companies, which each furnish one million, from the Thames.

The Vauxhall Company, which furnishes three millions, from the Thames, by steam engines.

And the East London Company, which furnishes twelve millions of gallons daily, from the river Lea, by steam engines.

Distribution.

The following table shows the number of houses and manufactories of all kinds, the length of the paved streets through which, by the terms of the law, the pipes are required to be laid, and the present probable daily consumption, in each ward of the city:

Wards.	No. of houses, manufactories, etc.	Length of streets paved: In feet.	Estimated daily consumption: In gallons.
No. I.	708	17,750	130,000
II.	595	14,650	150,000
III.	670	16,250	170,000
IV.	786	17,550	190,000
V.	621	13,050	160,000
VI.	502	17,650	110,000
VII.	591	10,375	150,000
VIII.	635	11,000	120,000
IX.	702	18,800	170,000
X.	731	12,520	150,000
Total.	6,541	149,595	1,500,000

It has been found impossible to obtain the exact distance and size of the pipes which are now laid down in the streets, belonging to the Water-works Company; but from the best

information that can be obtained, it is believed that there is upwards of forty thousand feet of iron and wood pipes laid, of which more than thirty thousand feet are of iron, from three to twelve inches in diameter.

The greatest head of water on any of these pipes, is about one hundred feet. Their strength and condition is not sufficiently known to determine whether they will stand a much greater pressure than is now upon them. From the quantity of water which is now delivered through them, it is believed that their capacity will generally be sufficient to convey the additional quantity which is required for the present estimated consumption.

In arranging a plan for the distribution, it is deemed best to prepare it without reference to the pipes already laid, but in the execution of the works, to omit laying down the new pipes, where those now in use are of sufficient strength and capacity to convey the necessary quantity of water.

When an increased supply is required, or the pipes which are now laid, fail, new pipes of increased size and strength may be substituted on the general plan now proposed.

Two distributing reservoirs at different elevations have been proposed, on each of the plans which have been examined.

The surface of the water, in the lower one, when full, will be one hundred and fifty-six feet above low water, and the upper one, on the Hudson river and Patroon's creek plans, two hundred and thirty-eight feet, and on the Hunger kill plan, two hundred and twenty-six feet above low water.

Generally the distribution from each of these reservoirs will be distinct from each other, the lower reservoir furnishing the supply below the level of Eagle street, and the upper one, above that level.

Means will be provided for connecting the two services, so that whenever occasion may require it, the whole supply may be obtained from the upper reservoir.

If the water should be obtained from the Hudson river, each reservoir would be supplied by the pump main. If it should

be obtained from either of the other sources proposed, the water would be delivered into the upper reservoir, and the lower one would be supplied by a main of twelve inches diameter, leading from the upper one.

For the *upper service*, the great main will be carried from the receiving reservoir through Washington and Eagle streets, where it will be connected wlth the mains of the lower service at Columbia, State, Hudson, and Lydius streets.

Another main will lead from the receiving reservoir, or from the main in Washington street to Arbor hill, and thence to North Pearl street, when it will be connected with a main of the lower service.

Another main will lead from the one in Washington, through Lark and Lydius to Eagle streets.

For the *lower service*, the great main will be carried from the lower reservoir, through Patroon to Pearl street, and down Pearl street to the southern boundery of the city.

A large main will extend through Broadway for the whole length of the city; one through Green; and another through Montgomery street.

Other mains will be laid from those in the upper service to near the river, through Lumber, Columbia, State, Hudson or Beaver, Lydius and Arch streets.

Service pipes will be laid through all the other streets in the city which are paved, and in other places where it is necessary to keep up the circulation of the water.

Stop cocks will be inserted at the intersection of all of the large pipes, and at frequent intervals in the small pipes.

One or two hydrants, as the case may require, with blow off cocks, will be placed near the intersection of all of the streets.

At the waste pipes, both on the upper as well as the lower service, public fountains can be erected.

When the full head of water from the upper reservoir is on the lower service pipes, a fountain at the corner of State street and Broadway would throw up a jet exceeding two hundred feet in height.

Water Works Company's Pipes.

The following statement has been made of the pipes which have been laid down by the Water Works Company:

Two pipes of six and eight inches diameter, one from the middle creek, and one from the Mazeilandt, north of Patroon's creek and west of the McAdam road, which cross the Patroon's creek near Broadway.

One twelve inch pipe from their reservoir down the railroad to Pearl street, and down Pearl to Patroon street.

8	in.	pipe	from	north bounds	down Broadway	to Patroon street.
6	"	"		"	Steuben	"
4	"	Steuben	street	"	State	"
3	"	"		"	"	"
4	"	State	"	"	Ferry	"
3	"	Ferry	"	"	Basset	"
8	"	Patroon	"	Pearl street	to Columbia	"
3	"	Columbia	"	"	Beaver	"
4	"	"	"	"	Arch	"
6	"	"	"	"	Hamilton	"
4	"	Hamilton	"	"	Arch	"
6	"	Pearl	"	Columbia	to Eagle	"

3 inch pipes: in Steuben from Broadway to Eagle; in State from Green to Eagle; in Beaver from Green to Daniel; in Hamilton from Broadway to Pearl; in Lydius from Liberty to Pearl; in Arch from Broadway to Pearl; and several short pieces in other streets.

Detailed estimates of all of the plans, and of various modifications which were suggested, are appended, from which it appears that the cost of each of the projects, exclusive of the damages for the water, is as follows:

	For supplying three millions of gallons per day.	For supplying six millions of gallons per day.
1. Hudson river,.....	$873,893 33	$1,205,280 00
2. Patroon's creek at the junc.,	629,845 00	746,214 00
3. Hunger kill, etc.,.....	851,405 00	949,861 50
4. Patroon's creek at Tivoli,..	574,953 33	698,541 66

The investigations which have been made, have led to the conclusion that the project for obtaining the supply of water from the Patroon's creek at the junction of the branch with the old line of the Mohawk and Hudson Railroad, combines the advantages of the purity of the water; an abundant supply, at an elevated head; and furnished at a moderate cost, in a more eminent degree than any other project.

I am very respectfully,
Your obedient servant,
WM. J. McALPINE,
Engineer.

NOTE.—A copy of the Act of the Legislature authorizing the construction of the works, is appended according to your directions.

EXPERIMENTS

Made in 1835–6, to determine the amount of water which could be collected in the reservoirs, proposed to be constructed for supplying the Chenango Canal.

Table No. 1. *Eaton Brook Valley.*

Months.	Rain Guage.	Falling water on an area of 6,800 acres.	Amount of water passing sluice, from same area.
	Inches.	*Cubic feet.*	*Cubic feet.*
1835, January, ...	1.15	28,386,600	52,662,528
February,.....	2.12	52,330,080	55,739,232
March,.....	1.18	29,127,120	60,155,136
April,.....	4.46	110,090,640	159,933,312
May, ...	2.68	66,153,120	88,129,728
	11.59	286,087,560	416,619,936
June	6.72	165,876,480	65,852,352
July, ...	2.74	67,634,160	30,951,072
August,.....	2.86	70,596,240	15,010,272
September,.....	1.34	33,076,560	10,636,704
October,.....	3.00	74,052,000	22,887,360
November,.....	2.20	54,304,800	26,346,816
December,.....	0.96	23,696,640	40,476,672
	19.82	489,236,880	212,161,248
1836, January, ...	5.63	138,970,920	51,489,216
February,.....	1.29	31,842,360	27,544,320
March,.....	1.00	24,684,000	54,835,488
April,.....	2.01	49,614,840	206,295,552
May, ...	4.77	117,742,680	88,873,632
	14.70	362,854,800	429,038,208
1835, Jan. to December,	31.41	776,324,440	628,781,184
June 1835, to June 1836,	34.52	852,091,680	641,199,456

Note.—At the commencement of the gauging in January 1835, the snow on the ground was equal to about two hundred millions of cubic feet of water. The melting of the snow caused the fluctuations in the ratio in the months of December to May, which is observable in the above table.

Table No. 2. Madison Brook Valley.

	Months.	Rain Guage.	Falling water on an area of 6,000 acres.	Amount of water passing sluice f'm same source
		Inches.	*Cubic feet.*	*Cubic feet.*
1835,	January, ...	2.17	47,262,600	15,711,840
	February, ...	2.50	54,450,000	40,107,744
	March, ...	1.03	22,433,400	48,052,224
	April, ...	5.00	108,900,000	89,103,456
	May, ...	1.98	43,124,400	66,899,520
		12.68	276,170,400	259,874,784
	June, ...	8.05	175,329,000	22,334,400
	July, ...	3.87	84,288,600	26,476,416
	August, ...	3.06	66,646,800	27,167,616
	September, ...	0.88	19,166,400	22,775,040
	October, ...	3.86	84,070,800	21,748,608
	November, ...	2.10	45,738,000	20,213,280
	December, ...	0.76	16,552,800	21,483,360
		22.58	491,792,400	162,198,720
1836,	January, ...	4.57	99,534,600	21,819,456
	February, ...	1.33	28,967,400	20,165,760
	March, ...	0.50	10,890,000	23,049,792
	April, ...	1.95	42,471,000	85,271,616
	May, ...	4.75	103,455,000	50,977,728
		13.10	285,318,000	201,284,352
Jan'y to December 1835,		35.26	767,962,800	422,073,504
June 1835, to June 1836,		35.68	777,110,400	363,483,072

Note.—At the commencement of the gauging, the snow on the ground was equal to about ninety millions of cubic feet of water. The melting of the snow caused the fluctuations during the winter and spring months. The construction of the reservoir, and the retention of the water in it, produced a uniformity in the discharge after the month of May, 1835.

The August number of the London Civil Engineer and Architect's Journal, contains a very interesting report on the subject of supplying Liverpool with water, lately made by Robert Stephenson, in which he states that the brooks in the district of Rivington having been accurately measured during the years 1847 and 1848, the proportion of available water was ascertained to be within 18 or 19 per cent of the whole rain fall.

The rain fall in 1847 and 1848, was an average of 55½ inches per annum.

The district of Rivington drains 10,400 acres.

He also states, that in the district of Belmont, which is near by, a water shed of 1,800 acres supplied an average of 3,463,-011 gallons per day throughout the year. The average fall of rain from 1843 to 1848, was 57½ inches per annum, which gives a ratio of about 54 per cent of the falling water which passed off through the brooks.

The water shed of the Bolton water-works reservoir is 520 acres, and the supply is stated at 900,000 gallons per day. If the fall of water is taken the same as at Belmont, the ratio would be about 49 per cent.

ESTIMATES.

1st. For obtaining three millions of gallons from the HUDSON RIVER, by a Pumping Engine.

Inlet Chamber at the Pier.

	Land,		$500
2,500	cubic yards excavation, at	$0 30	750
180	protection piles,	12 00	2,160
2,000	feet of wharfing,	0 30	600
800	c. yds. of stone in filter,	1 00	800
1,500	" embankment,	0 20	300
	Restoring streets and other incidental works,		500
15,000	feet bd. meas., timber and plank in caisson,	50 00	750
	Caulking, launching, bolts, &c.,		500
	Pumping water,		1,000
500	c. yds. masonry in well,	6 00	3,000
			$10,860

Supply Pipes under Canal Basin, to Pump Well.

4,000	c. yds. dredging earth,	$0 30	$1,200
8,000	" excavation on shore,	0 25	2,000
150,000	feet bd. meas., timber and plank in caisson and foundation,	50 00	7,500
100	guide piles,	12 00	1,200
	Caulking, launching, bolts, &c.,		3,000
	Protection for shore excavation,		500
5,000	c. yds. back filling,	0 10	500
800	" concrete about pipes, &c.,	6 00	4,800
	Repaving street,		200
	Pumping water,		2,000
1,000	lineal feet supply pipes, 26 in. diam.,	7 00	7,000
4	stop-cocks,	400 00	1,600
	Stop-gates in pier well, and screens,		500
			$32,000

Pump Well.

5,000	cubic yards excavation,	$0 20	$1,000
165	foundation piles,	3 00	495
10,000	feet bd. meas., timber and plank in foundation,	25 00	250
100	c. yds. concrete,	6 00	600
600	" masonry in well,	6 00	3,600
3,000	" embankment,	0 10	300
	Pumping water, &c.,		1,000
			6,245

Engine and Pumps.

A vertical condensing beam Engine, cylinder 58 in. diameter, stroke 12 feet,	$37,600
A duplicate horizontal non-condensing Engine and direct action pump, cylinder 2 ft. diameter, 6 ft. stroke,	10,000
2 plunger pumps, 21 in. diameter, 10 ft. stroke, air-chamber, pipes, &c.	9,000
Lot of land,	5,000
Engine-house, coal-house, &c.,	5,000
	$66,600

Rising Main and Filters.

4,200	lineal feet of 30 inch rising main,	$12 00	$50,400
3,100	" 20 " "	7 00	21,700
2	stop-cocks to 30 " "	500 00	1,000
2	" 20 " "	250 00	500
6	air-chambers, drop-valves, blow-off, &c.,	500 00	3,000
2	filters at reservoirs,	5000 00	10,000
			$86,600

The cost per day of running the Engine, will be:

4 tons of coal,	$5 00	$20 00
2 Engine men,	2 00	4 00
2 Firemen,	1 25	2 50
Oil, tallow, &c.,		2 00
Repairs of engines, pumps, &c.,		10 00
Per day,		$38 50
Per annum, $14,052.50, which is the interest, at six per cent, on a capital of,		$234,208 33

ESTIMATES.

2nd. For obtaining three millions of gallons from the upper sources of PATROON's and GATES' CREEKS, and delivering it by a conduit at a level two hundred and thirty-eight feet above tide.

Van Rensselaer Lake.

50 acres of land,	$25 00	$1,250
30 " chopping and clearing,	25 00	750
1,500 rods of fence,	1 50	2,250
Bridges and roads for farmers,		500

Dam.

1,000 c. yds. excavation, removing soil under embankment,	0 20	200
Grubbing,		150
3,000 c. yds. excavation for puddle wall,	0 12	360
30,000 " embankment,	0 12	3,600
4,000 " do. delivered and puddled,	0 35	1,400
1,200 " slope wall,	2 25	2,700
Turfing banks, &c.,		500
200 lineal feet of iron drain-pipe,	2 50	500
2 stop-cocks,	75 00	150
Puddling and other work about do.,		200

Gate-chamber, pipes, &c., ...		$1,500
Waste-weir, ...		1,500
House for gate-keeper, ...		500
		$18,010

If the dam is built at the Junction of the new branch of the Railroad, the cost will be as follows:

90 acres of land, ...	$25	00	$2,250
61 " chopping and clearing, ...	25	00	1,525
2,500 rods of fence, ...	1	50	3,750
100 c. yds. extra of slope wall, ...	2	25	225
Other items, the same as before, ...			13,760
Extra puddling and lining near dam,			1,500
			$23,010

Gates' Creek.

A dam 30 feet high, and a conduit 7,000 feet long, will introduce the water into either of the above reservoirs, at a level 15 feet above the conduit, the estimate for which is as follows:

20 acres of land, ...	$25	00	$500
15 " chopping and clearing, ...	25	00	375
600 rods of fence, ...	1	50	900
1,500 cubic yards excavation for puddle wall, ...		20	300
800 cubic yards excavation for base of embankment, ...		20	160
4,000 cubic yards puddling and material, .		35	1,400
25,000 " embankment, ...		12	3,000
1,200 " slope wall, ...	2	25	2,700
Turfing, &c., ...			400
200 lineal feet of drain pipe, ...	2	50	500
2 stop cocks, ...		75	150

Puddling about pipes,.....		$200
Gate chamber, &c.,.....		750
Waste weirs,.....		750
		$12,085

CONDUIT.

40,000 cubic yards excavation,.....	$0	10	$4,000
30,000 " back filling,.....		10	3,000
Grubbing,.....			100
Turfing,.....			150
Culverts and road crossing,.....			250
Waste weir and ventilator,.....			400
Gate chamber at dam,.....			750
7,000 lineal feet of conduit,.....	2	50	17,500
			$26,150

If pipes 16 inches diameter are substituted, the cost will be as follows:

7,000 lineal feet of pipe,.....	$4	50	31,500
3 stop & waste cocks and waste pipes,	150	00	450
Chamber at conduit,.....			500
			$32,450

Conduit 16,000 feet long from Van Rensselaer lake to the head of (west end) Patroon street:

20 acres of land,.....	$20	00	$400
12 " "	50	00	600
4,000 cubic yards rubble, concrete and mortar foundations,.....	5	00	20,000
6,000 cubic yards brick in arches,.....	6	00	36,000
5 waste weirs, ventilators and channels for discharge,.....	500	00	2,500
10 culverts and drains,.....	300	00	3,000

Extending Patroon's creek culvert,		$600
10 road crossings,	$25 00	250
Turnpike crossings,		150
Temporary fences,		500
		$64,000
Deduct diminished length of conduit by building the dam at the lower instead of the upper location,		10,800
		$53,200

1st. Section of Grading, from the Dam to the Buel Farm.

150,000 cubic yards of excavation,	$0 12	$18,000
70,000 " embankment and back-filling,	10	7,000
Temporary drains and bailing,		1,000
Grubbing,		150
Turfing banks and trimming slopes,		500
		$26,650

2d. Section of Grading, from the Buel Farm to the head of Patroon street.

40,000 cubic yards of excavation,	$0 10	$4,000
40,000 " embankment and back-filling,	10	4,000
Grubbing,		150
Turfing, &c.,		500
		$8,650

3d. Section, from the head of Patroon street to Reservoir at corner of Patroon and Perry streets.

3,000 lineal feet of iron conduit pipes two feet diameter,	$8 00	$24,000
2 stop-cocks,	350 00	700

2 drain pipes and stop-cocks,.....	$100 00	$200
Pipe chamber and discharge at station 30,.....		1,000
		$25,900

If the reservoir should be built at the north-west corner of Ontario and Patroon streets, then the estimate for Section No. 3 would be as follows:

3d Section—1,600 *feet of brick conduit.*

20,000 cubic yards of excavation and embankment,.....	$0 12	$2,400
2,000 cubic yards puddle,.....	25	500
1,600 lineal feet of brick conduit,.....	3 00	4,800
Turfing banks,.....		500
2 road crossings,.....		200
3 acres of land and damages,.....	200 00	600
		$9,000

Reservoirs.

Reservoir at corner of Patroon and Perry streets, 523 *by* 633 *feet.*

Land,.....		$6,000
62,000 cubic yards of excavation, at	$0 12	7,440
5,000 " retaining and division walls,.....	4 00	20,000
24,000 cubic yards earth puddled,.....	20	4,800
2,520 " brick pavement and in vaults,.....	6 00	15,120
6,000 cubic yards gravel lining, ...	50	3,000
Turfing,.....		500
Fencing,.....		500
60 c. yds stone masonry, ...	4 00	240
100 " concrete,.....	6 00	600
70,000 feet board meas. plank and timber,	20 00	1,400

	Inlet chamber,.....		$1,000
200	lineal feet inlet and outlet pipes,..	$6 00	1,200
4	stop-cocks,.....	350 00	1,400
	Connecting sluice and gates in division wall,.....		500
	Grading streets and laying drains,..		500
			$64,200

By reducing the capacity of this reservoir to fifteen millions of gallons, the outside wall may be omitted, and the depth of water reduced to ten instead of twelve feet usual depth. The cost will then be as follows:

	Land,.....		$6,000
27,000	cubic yards excavation,.....	$0 12	3,240
1,900	" division wall,.....	4 00	7,600
18,000	" earth puddled,.....	20	3,600
2,400	" brick pavement and vaults,.....	6 00	14,400
	Fencing,.....		1,000
	The other items, being the same, amount to.....		10,340
			$46,180

Reservoir at north west corner of Ontario and Patroon streets, 600 feet square.

	10 acres of land,.....	$500 00	$5,000
100,000	c. yds. of excavation,.....	12	12,000
27,000	" puddling,.....	20	5,400
2,900	" brick pavement and vaults,	6 00	17,400
5,200	" division and retaining walls,	4 00	20,800
6,000	" gravel lining,.....	50	3,000
50	" stone masonry in vaults,...	4 00	200
150	" concrete,.....	6 00	900
	Turfing &c.,.....		600
70,000	feet board measure foundation plank,	20 00	1,400

Fencing,		$500
Inlet chamber,		1,000
200 lineal feet inlet and outlet pipes,	$6 00	1,200
4 stop-cocks,	350 00	1,400
Connecting sluice and gates,		500
Grading and drains,		500
		$71,800

By omitting the outside walls, and substituting a fence ten feet high, and reducing the depth of the excavation, so as to give an usual depth of ten, instead of twelve feet of water, the capacity at ten feet deep, will be reduced from twenty-three to eighteen millions of gallons, and the cost will be as follows:

10 acres of land,	$500 00	$5,000
75,000 c. yds. of excavation,	12	9,000
25,000 " puddling,	0 20	5,000
2,700 " brick pavement and vaults,	6 00	16,200
2,200 " division walls,	4 00	8,800
6,000 " gravel lining,	50	3,000
50 " stone masonry in vaults,	4 00	200
150 " concrete,	6 00	900
Turfing &c.,		900
40,000 feet board meas. foundation plank,	20 00	800
Fencing,		1,000
The other items, being the same, amount to		4,600
		$56,100

Reservoir at the same location, 600 *by* 800 *feet, walls* 6 *feet high, water usually* 12 *feet deep.*

140,000 cubic yards of excavation, at	$0 12	$16,800
36,000 " puddling,	20	7,200
6,650 " stone masonry, division and retaining walls and vaults,	4 00	26,600
Turfing,		700

75,000 feet board meas. timber and plank in foundation,		$20 00	$1,500
Fencing,			600
12 acres of land,		500 00	6,000
3,500 c. yds. brick masonry, in pavement and vaults,		6 00	21,000
7,000 " gravel lining,		50	3,500
150 " concrete,		6 00	900
Inlet chambers,			1,000
200 lineal feet of outlet pipes,		6 00	1,200
4 stop-cocks for do.,		350 00	1,400
Connecting sluice and gate,			500
Grading and drains,			500
			$89,400

By omitting the walls and reducing the usual depth to ten feet, the cost would be as follows:

107,000 cubic yards excavation,		$0 12	12,840
34,000 " puddling,		20	6,800
3,050 " stone masonry, in division walls and vaults,		4 00	12,200
Turfing,			1,000
40,000 feet bd. meas. timber and plank in foundation,		20 00	800
Fencing,			1,200
Land, brick masonry, and other items as before,			36,000
			$70,840

Reservoir bounded by Patroon, First, Knox, and line of Dove streets; a rectangle 1,300 *by* 300 *feet, but extending at the N. W. corner beyond First street.*

The surface of the water when the pond is filled, is to be 156 feet above low water, and the depth below this level, is to be 30 feet, and arranged to receive 3 feet more in depth when necessary.

The first estimate will be based on the plan of occupying 30 feet of Patroon street, and discontinuing Lark street from First to Patroon, and First street from the line of Dove to Knox street, and arranged with reference to the present grade of Patroon street:

	Land,.....		$4,000
2,000	cubic yards retaining wall,.....	$4 00	8,000
3,000	" slope wall outside embankment,.....	2 00	6,000
85,000	cubic yards embankment,.....	12	10,200
33,000	" " puddled,.	20	6,600
16,000	" gravel lining and facing,	30	4,800
2,600	" brick pavement & vaults,	6 00	15,600
40,000	feet board measure, timber and plank,.....	20 00	800
2,200	lineal feet of surface drain,.....	1 50	3,300
	Turfing terrace, &c.,.....		1,000
	Fencing,.....		800
500	lineal feet of inlet and outlet pipes,	6 00	3,000
4	stop cocks,.....	350 00	1,400
	Grading and other drains not included above,.....		1,000
			$66,500

If the bank is built without encroachment on Patroon street, it will increase the cost four thousand dollars, and reduce the capacity six millions of gallons.

If Patroon street is raised to a grade of one in forty-five from Swan to Knox street, it will cost ten thousand dollars, and if Lark street is continued through the reservoir fifty-five feet wide, it will increase the cost three thousand dollars, and reduce the capacity four millions of gallons.

ESTIMATES.

3d. For obtaining three millions of gallons from the Block-house, Kaikout, and east branch of the HUNGER KILL, and delivering it by a conduit at a level two hundred and twenty-one and one-half feet above tide:

Reservoir on East Branch of Hunger Kill, lower location.

54	acres of land,	$25 00	$1,350
40	" chopping and clearing,	30 00	1,200
	Bridges and roads for farmers,		500
1,800	rods of fence,	1 50	2,700
	Dam.		
1,200	c. yds. of excavating remaining soil under embankment,	0 20	240
	Grubbing,		150
2,000	c. yds. excavation for puddle wall,	0 12	240
66,000	" embankment,	0 12	7,920
9,000	" puddle earth,	0 32	2,880
1,400	" slope wall	2 00	2,800
	Turfing banks, &c.,		800
380	lineal feet of iron drain pipe,	2 50	950
2	stop-cocks,	75 00	150
	Puddling and other work about do.,		200
	Gate-chamber, pipe, &c.,		1,500
	Waste-weir,		2,000
	House for gate-keeper,		500
			$26,080

If the dam be built at the upper location, the cost will be:

50	acres of land, and chopping,	$55 00	$2,750
	Grubbing,		250
21,000	c. yds. embankment,	0 12	2,520
3,500	" puddled earth,	0 32	1,120
700	" slope wall,	2 00	1,400
	Turfing banks, &c.,		500

300 lineal feet of drain-pipe,.....	$2	50	$750
Waste-weir, ...			1,500
Other items, the same as above,...			6,030
2,500 lineal feet 20 inch conduit pipe, ...	6	50	16,250
Blow-off cocks and drain-pipes,...			150
Extra gate at end of pipe and conduit,			750
			$33,970

Kaikout Reservoir.

25 acres of land, and chopping,.....	$55	00	$1,375
800 rods of fence, ...	1	50	1,200
Bridges and roads for farmers,.....			300
800 c. yds. excavation for base of embankment, ...	0	20	160
1,500 c. yds. excavation for puddle walls,	0	20	300
26,500 " embankment,.....	0	12	3,180
4,500 " earth puddled,.....	0	35	1,575
1,200 " slope wall,.....	2	25	2,700
Turfing banks, &c., ...			500
200 lineal feet drain-pipe,.....	2	50	500
2 stop-cocks, ...	75	00	150
Puddling and other works about do.,			200
Gate-chamber, &c., ...			750
Waste-weir,.....			750
House for gate-keeper,.....			500
			$14,140

4,100 lineal feet 16 inch conduit-pipe,...	$4	50	$18,450
Pipe-chamber,.....			500
3 stop & waste cocks and waste pipes,	150	00	450
Gate-chamber at conduit, ...			500
Extra work from water and crossing streams, and grubbing,.....			250
			$20,150

Block House Reservoir.

15 acres of land,	$55	00	$825
500 rods fence,	1	50	750
Bridges and roads,			150
2,000 c. yds. excavation for puddle and base of embankment,		20	400
2,000 c. yds. embankment,		12	240
7,000 " puddled earth,		35	2,450
800 " slope wall,	2	25	1,800
Other items as above,			2,350
			$8,965
3,400 lineal feet of conduit pipe, 12 inches diameter,	$3	00	$10,200
Pipe chamber, stop cocks, and extra work,			1,500
			$11,700

Conduit, 43,700 feet long.

70 acres of land,	$50	00	$3,500
9,300 c. yds. rubble and concrete,	5	00	46,500
14,200 " brick arches,	6	00	85,200
15 waste-weirs and ventilators, and channels of discharge,	500	00	7,500
26 drains,	200	00	5,200
9 small culverts,	400	00	3,600
6 large culverts,	600	00	3,600
Kaikout and block house culverts,			3,000
14 road crossings,	25	00	350
2 turnpike crossings,	150	00	300
Temporary fences,			1,000
			$159,750
If pipes are substituted for the brick conduit, for passing over the Kaikout, it will reduce the expense,			19,055
			$140,695

1st. Section of grading, from the dam on the east branch of the Hunger kill to the Block house.

	Grubbing,		$200
60,000 c. yds.	of excavation,	$0 10	6,000
240,000 "	embankment and back filling,	11	26,400
12,400 "	supporting wall,	$2 25	27,900
	Turfing banks, etc.,		1,500
			$62,000

2d. Section, from the Block house to the east branch of the Crommie kill.

	Grubbing,		$800
95,000 c. yds.	excavation,	$0 10	9,500
140,000 "	embankment,	10	14,000
2,300 "	supporting wall,	2 25	5,175
	Turfing banks, etc.,		750
	Changing roads,		300
			$30,525

3d. Section, from the Crommie kill to the Railroad.

	Grubbing,		$300
95,000 c. yds.	excavation,	$0 10	9,500
50,000 "	embankment,	10	5,000
	Turfing banks, etc.,		400
			$15,200

4th. Section of Grading, along Railroad to the commencement of the Pipe Section.

25,000 c. yds.	of excavation,	$0 11	$2,750
35,000 "	back filling,	10	3,500
	Turfing banks,		200
			$6,450

5th. Pipe Section.

3,800 lineal feet conduit pipes, 2 feet diameter,	$8 00	$30,400
2 stop cocks,	350 00	700
2 drain pipes and cocks,	100 00	200
Pipe chamber and discharge at station 38,		1,000
		$32,300

If the reservoir should be constructed west of the Orphan Asylum, it would reduce the expense of this section, $2,500.

If the Kaikout be crossed with pipes instead of a brick conduit and embankment, it would cost as follows:

4,000 c. yds. of excavation and embankment,	$0 10	$400
Culvert over Kaikout,		600
600 lineal feet of 20 inch conduit pipe,	6 50	3,900
2 stop cocks,	300 00	600
Blow off cocks and drain pipes,		150
1 extra gate chamber,		1,000
		$6,650

The cost of crossing by the conduit is as follows:

5,600 c. yds. supporting wall,	$2 25	$12,600
77,000 " embankment,	12	9,240
200 " brick masonry in conduit,	6 00	1,200
113 " concrete and rubble foundation,	5 00	565
Culvert,		1,600
Turfing, etc.,		500
		$25,705
		6,650
The saving by substituting pipes is,		$19,955

Reservoirs.

Reservoir, 560 *by* 800 *feet—South of Orphan Asylum, corner of Robin and State streets.*

	Land,		$8,000
125,000	c. yds. excavation,	$0 12	15,000
3,300	" stone masonry in division wall, &c.,	4 00	13,200
39,000	" Puddling,	0 20	7,800
	Turfing,		1,000
	Fencing,		1,200
40,000	feet board meas. foundation timber and plank,	20 00	800
3,200	c. yds. brick pavement and vaults,	6 00	19,200
7,000	" gravel,	0 50	3,500
140	" concrete,	6 00	840
	Inlet chamber,		1,000
200	lineal feet of inlet and outlet pipe,	6 00	1,200
4	stop-cocks for do.,	350 00	1,400
	Connecting sluice and gates,		500
	Grading and drains,		500
			$75,140

The above estimate is based upon building the banks without retaining walls, and providing for a depth of 12 feet of water, ordinarily giving a capacity of thirty millions of gallons.

2d. Location at corner of Perry and Washington streets—490 *by* 430 *feet.*

	Land,		$4,000
25,000	c. yds. excavation,	$0 12	3,000
15,000	" puddling,	0 20	3,000
2,400	" stone masonry, in division wall, &c.,	4 00	9,600
1,400	" brick do. in pavements, &c.,	6 00	8,400

	Fencing,		$800
	Turfing,		500
4,000	c. yds. gravel,	$0 50	2,000
30,000	feet foundation plank and timber,	20 00	600
80	c. yds. concrete,	6 00	480
	Other items, same as above,		4,600
			$36,980

Estimate of the additional cost of increasing the supply to six millions of gallons:

Reservoir on the West branch of the Hunger Kill.

140	acres of land,	$25 00	$3,500
70	" chopping and clearing,	30 00	2,100
	Bridges and roads,		1,000
2,500	rods of fence,	1 50	3,750
	Dam.		
	Grubbing,		150
1,000	c. yds. excavation, removing soil, &c.	0 20	400
4,000	" " for puddle wall,	0 12	480
130,000	" embankment,	0 12	15,600
18,000	" puddled earth,	0 32	5,760
2,300	" slope wall,	2 00	4,600
	Turfing banks, &c.,		1,500
380	lineal feet of iron drain-pipe,	2 50	950
1	stop-cock,		75
	Puddling and other work about do.,		200
	Waste-weir,		2,000
			$42,065
	Add for another pipe crossing the Kaikout, 2 feet diameter,		$7,750
	Also for another from Station 38 to receiving reservoir,		30,600
			$38,350

ESTIMATES.

4th. For obtaining three millions of gallons from PATROON'S CREEK, below and near Tivoli Falls:

Tivoli Reservoir.

40 acres of land,.....	$150	00	$6,000	
10,000 c. yds. earth excavation,	0	12	1,200	
1,200 " rock "	0	50	600	
20,000 " puddling,.....	0	20	4,000	
60,000 " embankment, ..	0	12	7,200	
50,000 " gravel,.....		20	10,000	
1,000 " slope wall, ...	2	00	2,000	
9,000 lineal feet drains,.....	1	00	9,000	
6,000 c. yds. embankment in catch-water dams,..	0	15	900	
150 c. yds. masonry in stone dam,.....	7	00	1,050	
Gate-chamber & fixtures,			500	
2,000 lineal feet conduit on north bank, ...	3	00	6,000	
400 c. yds. masonry in well chamber,.....	6	00	2,400	
Gates, fixtures, &c.,..			400	
2,000 lineal feet connecting and distributing pipe,	6	00	12,000	
6 stop-cocks for do.,..	250	00	1,500	
90 c. yds. masonry, connecting well, &c.,...	6	00	540	
Waste-chamber,.....			500	
				$65,790 00
1,500 lineal feet 12 inch pipe, extending present line to the dam,.....	$3	00	$4,500	
9,000 do. 10 in., do. to corner Eagle & Columbia sts.	1	75	15,750	
Stop-cocks, blow-offs, &c.,			1,000	
				$21,250 00

Pump-well, foundation and engine-house,..		$6,000	
Engine, cylinder 24 in. diameter, 6 ft. stroke, and pumps, ...		9,000	
Duplicate engine & pumps,		5,000	
			$20,000 00
2,100 lineal feet rising main, 12 in. diameter,....	$3 50	$7,350	
Stop-cocks, air-chamber, &c.,		700	
Land,.....		1,000	
			$9,050 00
Cost of running the engine one day, $13			
Per year,.....		4,755	
Which represents a capital of,.....			$79,083 33

DISTRIBUTION.

65,000	lineal ft.	pipe,	3	in. diam.,	$0 60	$39,000
40,000	"	"	4	"	0 90	36,000
15,000	"	"	6	"	1 25	18,750
13,000	"	"	8	"	1 40	18,200
2,500	"	"	10	"	1 60	4,000
5,800	"	"	12	"	2 50	14,500
						$130,450 00
200	stop-cocks for	pipes,	3	"	$20 00	$4,000
160	"	"	4	"	25 00	4,000
60	"	"	6	"	35 00	2,100
40	"	"	8	"	50 00	2,000
20	"	"	10	"	70 00	1,400
10	"	"	12	"	75 00	750
700	hydrants, ...				25 00	17,500
						$31,750 00
Pipe yard & buildings and testing apparatus,						4,000 00
Miscellaneous expenses,.....						8,800 00
						$175,000 00

SUMMARY

OF THE ESTIMATES FOR A SUPPLY OF THREE MILLIONS OF GALLONS.

I. *From the Hudson River.*

Inlet chamber at the pier,.....	$10,860	
Supply pipes under canal basin,.....	32,000	
Pump well,.....	6,245	
Engine, pumps, house and land,.....	66,600	
Rising mains and filters,.....	86,600	
Lower reservoir, at Patroon and Lark streets,.....	66,500	
Upper reservoir, at Patroon and Perry streets,.....	46,180	
		$314,985 00
Distribution, ...		175,000 00
Payment to Water Works Company, est'd at,..		108,600 00
Contingencies and superintendence, ten per cent on $490,000,.....		49,000 00
		$647,585 00
To compare this plan with the others, there should be added, a capital, the interest of which will pay the expense of running the engine, equal to,.....	$234,208 33	
There will be saved in the connecting pipe between the two reservoirs, in comparing the plans,.....	7,900 00	
		$226,308 33
Total cost of this plan, ...		$873,893 33

II. *From the Patroon's Creek, near the Junction.*

Junction reservoir,.....	$23,010	
Gates creek,.....	12,085	
Connecting pipes between them,.....	32,450	

Conduit from Junction dam to receiving reservoir,	$53,200	
1st section of grading,	26,650	
2d " "	8,650	
3d " "	9,000	
Upper reservoir, corner of Patroon and Ontario streets,	56,100	
Lower reservoir, corner of Patroon and Lark streets,	66,500	
Distribution,	175,000	
Payment to Water Works Company,	108,600	
		$571,245 00
Contingencies and superintendence, 10 per cent on $490,000,		49,000 00
To compare this with the other plans, there should be added the expense of bringing the distribution pipes to the lower location of the upper reservoir,		9,600 00
Total cost, exclusive of damages, for water,		$629,845 00

III. *From the Block house, Kaikout and Hunger kill.*

Reservoir on the east branch of the Hunger kill,	$26,080
Reservoir on the Kaikout,	14,140
" " Block house,	8,965
Connecting pipe from Kaikout reservoir to Conduit,	20,150
" " Block house,	11,700
Conduit and pipes from the east branch of the Hunger kill to the receiving reservoir,	140,695
1st section grading for conduit,	62,000
2d " " "	30,525
3d " " "	15,200
4th " " "	6,450
5th " pipes,	32,300

Upper receiving reservoir, of the same size as estimated for the Patroon's creek, will cost the same, viz:	$56,100	
Lower reservoir, corner of Patroon and Lark streets, ...	66,500	
Distribution, ...	175,000	
Payment to Water Works Company,	108,600	
		$774,405 00

The water by this plan, would be delivered 16.4 feet lower than on the other plans. To make the comparison between the projects, there should be added to this estimate, the cost of elevating the water to the same height as on the other plans, viz:

First cost of engine and pumps, ...	$2,000	
Capital, the interest of which will pay the expense of running the engine, ..	8,000	
		10,000 00
Contingences and superintendence, ten per cent on $670,000, ...		67,000 00
Total cost exclusive of damages for water, ...		$851,405 00

IV. *From the Patroon's Creek at Tivoli Falls.*

Tivoli reservoir, ...	$65,790	
Compensating reservoir at Junction, ..	15,000	
Extension of Company's pipes to reservoir, etc., ...	21,250	
Engine, pumps, house, etc., ...	20,000	
Rising main, etc., ...	9,050	
Upper reservoir, corner Patroon and Ontario streets, ...	46,180	
Distribution, ...	175,000	
Payment to Water Works Company,	108,600	
		460,870 00
Contingencies and superintendence, ten per cent on $350,000, ...		35,000 00
		$495,870 00

To compare this plan with the others there should be added, a capital, the interest of which would pay the expense of running the engine, viz:	79,083 33
Total cost exclusive of damages for water,....	$574,953 33

SUMMARY

Of the Cost of obtaining a Supply of six millions of Gallons.

I. *From the Hudson River.*

The inlet chamber, supply pipes and pump-well, already estimated are sufficient for the maximum supply.		
One additional engine of the same size,	$37,600	
One " set of pumps,.....	9,000	
Enlarging engine and coal house,....	2,000	
Additional rising main, stop-cocks and air chambers,.....	76,600	
		$125,200 00
Contingences ten per cent,.....		12,520 00
Add the estimated cost of furnishing three millions, exclusive of the capital to pay for running engine,.....		646,585 00
		$784,305 00
A capital the interest of which will pay for running the first engine,..... ...	$226,308 33	
Additional capital required to run the second engine, (per day, $32, per annum, $11,680,)....	194,666 67	
		420,975 00
Total amount of this plan, ...		$1,205,280 00

II. *From the Patroon's Creek at the Junction.*

Tivoli reservoir, per estimate on the fourth plan, ...	$65,790	
5000 lineal feet of main from the above, to the reservoir, corner of Patroon and Lark streets,..... $8 00	40,000	
Contingences ten per cent on $105,790	10,579	
		116,369 00
Add the cost of furnishing three millions,.....		629,845 00
Total cost exclusive of damages for water,		$746,214 00

Or if the additional supply is obtained by turning in the waters of Lyches kill and Shaker brook, the cost will be as follows:

Lyches Kill.

Building new dam on creek,	$5,000	
24 acres land, & clearing, $55 00	1,320	
150,000 c. yds. excavation,... 15	22,500	
10,000 " puddling,.... 35	3,500	
Enlarging railroad ditch, and walling it,.....	4,000	
Enlarging storage reservoir,	20,000	
Cost exclusive of damages for water,.....		$56,320 00

Shaker Brook.

Building dam,.....	5,000	
20 acres land, & clearing, $35 00	700	
300,000 c. yds. excavation,... 15	45,000	
Enlarging storage reservoir on Gates creek,.....	10,000	
		60,700 00
Ten per cent, for contingencies, on $117,000,.....		11,700 00
		$128,720 00
Add the cost of furnishing three millions,		629,845 00
Total cost exclusive of damages for water,		$758,565 00

III. *From the Hunger Kill.*

Reservoir on west branch Hunger kill,.....	$42,065 00	
Additional pipes crossing Kaikout, and on Section No. 5,.....	38,350 00	
Contingencies 10 pr. ct. on $80,415,	8,041 50	
		$88,456 50
Expense of raising the water 16.4 feet, as before,		10,000 00
		$98,456 50
Add the cost of furnishing three millions,.....		$851,405 00
Total cost exclusive of damages for water,		$949,861 50

IV. *From the Patroon's Creek, at Tivoli.*

5,000 lineal feet of iron mains, $8,	$40,000	
Another engine, ...	9,000	
" rising main, stop-cocks, &c,	8,050	
Contingencies ten per cent on $57,050,	5,705	
		$62,755 00
Add the cost of furnishing three millions,.....		495,870 00
		$558,625 00
Capital required to run 1st engine, as before,.....	$79,083 33	
Capital required to run 2d engine,	60,833 33	
		139,916 66
Total cost exclusive of damages for water,		$698,541 66

SUPPLEMENTARY REPORT.

ALBANY, August 3, 1850.

To JAMES STEVENSON, ERASTUS CORNING, JOHN TOWNSEND,
JOHN TAYLOR, and ROBERT E. TEMPLE, Esquires,
Water Commissioners of the City of Albany:

GENTLEMEN:

Since I presented my report on the first instant, I have received your directions to so reduce the work, if possible, as to bring the expenditure within the amount which the law authorizes the Common Council to provide for constructing the works, specifying such items as can be omitted for the present, without causing future extra expense, when the increased demand for water shall require the enlargement and extension of the works to the size contemplated in my former report.

The plans for each of the projects, which were presented in my former report, contemplated furnishing an average of three millions of gallons of water daily.

In that report, it was stated that this supply would be sufficient when the population of the city had increased to twice the present number.

For the present time therefore, a supply of one and a half millions of gallons will answer, but with a view to provide for an immediate increase in the number of manufactories, and for other purposes which would require a large quantity of water, it is considered advisable to take this supply at two millions.

It has been stated that the present Water-works Company furnish daily eight hundred thousand gallons to their consumers.

This quantity is obtained from the following sources, viz:

From the Maizelandt kill, and delivered in the lower part of the city, through an iron pipe eight inches in diameter.

From the Middle creek, by a pipe part of the way six inches, and the remainder four inches in diameter.

And from the Patroon's creek, near the Tivoli factory, by a wooden pipe twenty-four inches in diameter part of the way, and thence by an iron pipe twelve inches in diameter as far as Clinton Park.

Objections have been made by the citizens to all of these waters. To the two first, on account of their hardness, and to the latter, on account of its being frequently delivered in a very turbid state.

There is no remedy for the former, but the objection to the latter can be easily corrected either by filtering the water or by extending the pipes to the upper pond, and enlarging and altering it.

If a division wall is made in this pond, and the stream is turned so as to prevent the water from entering the division from which the supply is taken, until it has deposited its sediment, this objection will be overcome.

The pipes above referred to, from this place have been recently laid, and may be in good order.

They ought, under such circumstances, to deliver a million of gallons per day for the use of the lower part of the city; but as their condition is not known, it will not be safe to rely upon them for this amount.

The Company has also an eight inch pipe laid down in the north end of the city, which can be turned up the creek and receive its supply from the same place as the twelve inch pipe.

The estimates will be predicated on furnishing a supply of twelve hundred thousand gallons, besides that which can be obtained by the present arrangements of the water-works company.

One-half of this quantity should be delivered in the highest part of the city, and the other half into an intermediate reservoir.

Reservoirs for the upper and lower service, are required for each of the plans.

The head of the water on the old pipes would be so great, if not reduced by an intermediate reservoir, that it would endanger their security.

To reduce the head of water, however, would only require a tank or a very small reservoir. The one built by the waterworks company at the corner of Eagle and Columbia streets, will answer for this purpose.

It is believed, however, that the lots which this reservoir occupy, could be sold for a sum sufficient to pay the cost of building one on Patroon street, which would contain over ten millions of gallons.

For this purpose, the present pond would be used for a reservoir by placing a lining of puddle along the north slope of the embankment of Patroon street, and protecting the banks from abrasion, and the waters from becoming turbid, by a coating of coarse clean gravel, and by building catch water drains around the northern and western sides of the reservoir.

The water in this case would be raised to within four feet of the level of Patroon street, which would give a depth of ten feet over an area of four acres.

By constructing a filter, the expense of the division wall may be avoided.

But a small amount of this work would be lost when the reservoir is hereafter enlarged to the original plan.

The changes which can be made in the upper reservoir, would be to make it of less depth, by which means a less thickness of puddling in the bottom would be required.

The bottom puddling could be covered with coarse gravel instead of a pavement.

The banks could be built with the inside slopes upon the lines proposed in the original plan, so that they may be enlarged without requiring the removal of any of the materials now put in, and a filter may be substituted for the division wall.

In enlarging this reservoir to the original plan, the work on the bottom would be lost.

In the plan of distribution proposed in the former report, it was proposed to substitute iron pipes for all of the wooden pipes which have been laid down by the water-works company.

As these pipes now generally perform the service required, this expense may for the present be avoided.

In laying down the pipes in the streets in some cities, they have omitted to put in as many stop cocks, as subsequent experience has shown to be necessary for the convenience of the inhabitants.

In the former report, a large provision for stop cocks was made, but with a view to economise the present expenditures, a number of these cocks in the sparse districts of the city may be omitted.

The expense of putting in these cocks hereafter, will be considerably increased.

An eight inch main which has been estimated for, running from the lower reservoir on Patroon street to Eagle street, may be omitted at present. The supply to the Eagle street main may be obtained direct from the upper reservoir.

I. *From the Hudson River.*

The works at the pier under the basin, and at the pump well, which require expensive preliminary arrangements for constructing them, should be built nearly as has been stated in the former report.

Instead of constructing the large condensing engine, one of half the size can be substituted so as to deliver the quantity now proposed to be furnished. When the demand for water increases, the engine may be run a greater number of hours, until it becomes necessary to construct an additional engine.

Pumps of less size, and a rising main of only twenty inches diameter leading to the lower, and one of sixteen inches diameter to the upper reservoir, would be required.

When a larger supply is required, additional mains can be laid down.

In the former report, for the purpose of making a comparison between the different plans, a capital, the interest of which would pay the expense of running the engine, was added to the estimate.

In comparing the different plans under the present views of the case, a similar sum must be added, but in neither case would there be an expenditure of these sums, and therefore they will be omitted in stating the actual cost of the works.

II. *From the Patroon's Creek.*

The creek at the junction, without the aid of the Gates creek, will furnish the balance of the supply, which is now contemplated after deducting that which can be procured from the works of the present water-works company.

The dimensions of the conduit proposed in the former report, are sufficient to deliver six millions of gallons daily.

Its size may be reduced so as to deliver three millions, but this will render it very difficult to enter and examine it.*

In the former report, it was stated that a supply of six millions of gallons could be procured either from the Patroon's creek at Tivoli falls, from the junction, or by turning in Lyches kill and the Shaker brook.

If it should be necessary to bring in the last mentioned streams, the labor on the conduit will be almost wholly lost, if it is made only large enough to deliver three millions of gallons.

If the increased supply should hereafter be obtained from the Patroon's creek at Tivoli, then the change in the size of the conduit may be made without involving any subsequent extra cost. Under all the circumstances, it is recommended

* A conduit of two and one-half feet diameter, when running full, will discharge three and one-half millions of gallons per day, with one foot descent to the mile, and will discharge three millions when the water is running in it, two feet deep.

that the size of the conduit proposed in the former report be retained.

III. *From the Hunger kill and the intermediate streams.*

In the former report, the Block House and Kaikout were proposed to be taken into the conduit as tributaries.

These two streams, together with the quantity which can be obtained from the water-works companies' sources, will furnish the supply now contemplated.

The same remarks which have been before made in reference to the size of the conduit, will apply to this plan.

IV. *From the Patroon's creek below Tivoli falls, supplying the lower service by gravitation, and the upper service by elevating the water from the same place by mechanical power.*

The quantity of water which the stream will afford in its lowest stages at this place, is more than is now required for use.

The company's twelve inch pipe should be extended to this pond, which will give more head upon it and increase its discharge.

Another pipe of ten inches diameter should be laid down so as to furnish the supply of water for the lower service, above the level of Pearl street.

In this plan, the expense of an intermediate reservoir on Patroon street may be saved, as the distribution can be made directly from the receiving reservoir below Tivoli falls.

The engine and pumps would be placed in the pond as before; but this, being on a lower level than the reservoir designed in the former report, would require the water to be elevated about one hundred and ten feet.

An engine of the size proposed in the former report, viz: a steam cylinder of twenty-four inches diameter and six feet stroke, would have abundant power for this purpose. The upper reservoir would be common to both plans.

A rising main of twelve inches diameter was proposed in the former report, which was sufficient to deliver one million

of gallons per day. One of smaller size would answer for the present plan, but the estimate will be based on a twelve inch main, with the remark that one of this size will be sufficient, until the quantity required to be passed through it is doubled.

The compensating reservoir which was proposed in the former report to be built at the Junction, will also be required on this plan, although its dimensions can be reduced a little in consequence of taking less water from the stream at Tivoli.

ESTIMATES

OF THE COST OF FURNISHING TWO MILLIONS OF GALLONS OF WATER, INCLUDING THAT FURNISHED BY THE PRESENT WORKS OF THE WATER-WORKS COMPANY.

Items of Expense common to each Plan.

Receiving reservoir,.....	$25,400 00
Enlarging pond at foot of Tivoli falls,.....	20,000 00
Extending pipes from the lower to the upper pond at Tivoli,.....	5,000 00
Repairs and additions to Water-works Company's works,.....	5,000 00
Payment to the Water-works Company, estimated at,.....	108,600 00
Distribution-pipes, stop-cocks, hydrants, &c.,..	140,000 00
	$304,000 00

I. *From the Hudson River.*

Chamber at Pier, supply-pipes and pump-well, as in former estimate,		$49,105 00
Engine and pumps, and duplicates; engine and coal-houses, and land,		40,000 00
Rising-mains, stop-cocks, blow-offs, &c.,		46,900 00
Items common to each plan,		304,000 00
Contingencies, &c., ten per cent on	$371,000	37,100 00
Total cost of this plan,		$477,105 00
To compare this with the other plans, there should be added, a sum, the interest of which would pay the expense of running the engine, equal to,		117,104 16
Total amount,		$594,209 16

II. *From the Patroon's Creek, at the Junction.*

Junction reservoir,		$23,010 00
Conduit and land,		41,000 00
Waste-weirs, culverts, and road crossings,		6,400 00
Grading and conduit,		63,150 00
Items common to each plan,		304,000 00
Contingencies, &c., ten per cent on	$330,000	33,000 00
Total cost, exclusive of damages for water,		$470,560 00

III. *From the Blockhouse, Kaikout, &c.*

Kaikout reservoir,		$14,140 00
Blockhouse "		8,965 00
Pipes from these reservoirs to conduit,		31,850 00
Conduit, land, waste-weirs, culverts, &c.,		79,250 00
Grading and conduit,		78,050 00
Items common to each plan,		304,000 00
Contingencies, &c., ten per cent on	$407,000	40,700 00
Total cost, exclusive of damages for water,		$556,955 00

IV. *From the Patroon's Creek, at Tivoli Falls.*

Engine and pumps, and duplicates,.....	$20,000 00
Rising-main, stop-cocks, &c., and land,.....	9,050 00
Additional cost of enlarging Tivoli reservoir,...	20,000 00
Extending a supply-main from do. to Eagle st. reservoir, ...	16,250 00
Compensating reservoir at Junction,.....	15,000 00
Items common to each plan,.....	304,000 00
Contingencies, &c., ten per cent on...$276,000	27,600 00
Total cost, ...	$411,900 00
To compare this with the other plans, there should be added, a sum, the interest of which would pay the expense of running the engine, equal to,.....	79,083,33
Total amount, exclusive of damages for water,..	$490,983 33

Very respectfully,

Your obedient servant,

WM. J. McALPINE, *Engineer.*

NOTE.—Since the preceding report was written, I have received a copy of "The Report of the General Board of Health, on the Supply of Water to the City of London," published a few weeks since, which contains the following table of the number of houses; of the whole amount of water supplied; and the average supply to each private house—being the gross daily supply for the year 1849, from each of the Water-works Companies:

TABLE.

Companies.	No. of Houses.	Galls. to each House.	Total gallons supplied.
New River,	83,206	158	14,149,315
East London,	56,409	140	8,829,462
Southwark,	34,217	146	6,013,716
Middlesex,	24,480	124	3,334,054
Lambeth,	23,396	107	3,077,260
Chelsea,	20,893	169	3,940,730
Grand Junction,	13,858	222	3,532,013
Kent,	9,632	101	1,079,211
Hampstead,	4,490	90	427,468
Total,	270,581	....	44,383,332

The average number of persons to each house, in the Provincial towns, is about seven; but in London, the average number is probably more. The whole number of houses in London is about two hundred and eighty-eight thousand. The average supply to each person is therefore less than thirty gallons per day.

ALBANY WATER WORKS.

ARTICLES OF AGREEMENT

Made and concluded this
day of in the year eighteen hundred
and fifty. BETWEEN

of the one part, and the WATER COMMISSIONERS OF THE CITY OF ALBANY, of the other part, whereby it is covenanted and agreed as follows, to wit: The said

hereby covenant and agree , that will furnish all of the materials (except those which may be furnished by the aforesaid Water Commissioners,) which are required, all of which shall be sound, durable, and of the best quality, for the purposes required, and such as shall be approved of by the Chief Engineer, for the time being,

in the employment of the said Commissioners; and perform all of the labor necessary to construct and finish in the most workmanlike and substantial manner.

The construction of the said work shall be in all respects, according to the annexed specifications, which are to be considered as a part of this contract.

No public or private road shall be obstructed or disturbed, nor shall any lands be entered upon, until directions shall be given to do so by the said Engineer.

The said contractor hereby agree to keep gates shut and secured, and fences in good repair, and to be responsible for all damage which may be done by any person or animal in employ, to the lands, buildings or crops contiguous to the said work, or through which they may pass to or from said work; and if any damage shall be done, as aforesaid, it is hereby agreed, that the said Commissioners may, on the certificate of the said Engineer, pay for such damage, and deduct the same from any monies which may become due to the said Contractor under this contract.

It is further agreed, that the work embraced in this contract shall be prosecuted in such order and at such places and parts of the work, and at such times and seasons as the said Commissioners or the said Engineer may direct.

And the said Contractor further agree, that will not employ unfaithful or incompetent workmen or overseers, or disorderly persons; and that will immediately discharge any person in employ who is declared

to be so, and whenever directed by the said Commissioners or the said Engineer.

And the said Contractor further agree , that will not of or by agents, give or sell any ardent spirits to workmen, or to any person on or near the line of the said work, or allow any to be brought on or sold by, or to any person in employment.

And the said Contractor further agree , that will perform the several stipulations of this contract by and by workmen under immediate superintendence, and not by a sub-contractor. And also, that will give own undivided attention to the work, and will not assign or transfer interest to any person or persons without the concurrence of the said Commissioners and the Common Council of the city of Albany.

And the said Contractor hereby agree , that will perform this contract as specified, but will make any alterations in the form, dimensions or materials which may be directed in writing by the said Commissioners or the said Engineer; and to prevent all disputes, it is hereby agreed, that the said Egineer shall, in all cases, determine the amount or quantity of the several kinds of work which are to be paid for under this contract, and the amount of compensation at the rates herein provided for; and shall also determine the value of any extra work for which prices have not been named in this contract; and shall also decide every question relating to the execution of this contract, on the part of the said Contractor , and his estimate and decision shall be final and conclusive.

It is further agreed, that whether the work embraced in this contract be enlarged or diminished, or the dimensions changed from the plans herein contemplated, the same shall be done by the said Contractor but the prices shall remain the same; and if the said Commissioners shall fail

to furnish any portion of the brick, or other materials herein understood to be furnished by them, or shall fail to procure the right to enter upon any lands which may be necessary for the prosecution of the work, it shall not entitle the said Contractor to any claim for damages in consequence thereof; but either of the parties shall be at liberty to abandon so much of this contract, as shall be affected by such failure to deliver materials or to procure land.

AND THE SAID COMMISSIONERS DO HEREBY ENGAGE, that whenever, in the opinion of the aforesaid Chief Engineer, this contract shall be wholly completed on the part of said Contractor they will pay for the same in drafts on the Chamberlain of the city of Albany, at the following rates, viz:

For clearing and chopping, at the rate of

dollars per acre, measuring the land which is actually cleared or chopped.

For grubbing and clearing, at the rate of

dollars per acre, measuring as aforesaid.

For all excavation of earth of every description, and the labor of removing the same, whether it be in embankment and backfilling, within a distance of two hundred feet, or spoil bank, and including all bailing or draining of water, and coffer dams, and other protections to the works, at the rate of cents per cubic yard.

For all embankment and backfilling which is not obtained from excavation within two hundred feet, including bailing, draining, etc., as above stated, and also the labor of wetting and ramming the materials, at the rate of

cents per cubic yard.

For all gravel, stone and clay, denominated "lining," which may be required to be hauled a distance exceeding one thousand feet, and including the labor of wetting and ramming the same, at the rate of

cents per cubic yard.

For the labor of puddling, by wetting and cutting with a spade, as described in the specifications hereunto attached, at the rate of

cents per cubic yard.

For slope walls and pavements, laid without cement, at the rate of

cents per cubic yard.

For rubble masonry, laid in hydraulic mortar, at the rate of

cents per cubic yard.

For concrete masonry, as above, at the rate of

cents per cubic yard.

For cut stone masonry, as above, used for jambs, corners, coping, ring stone, etc., at the rate of

cents per cubic yard.

For transporting brick and laying them up in masonry, including mortar and plastering, over and under the arches and the centers, and all other materials and labor, except furnishing the brick, at the rate of

cents per cubic yard.

For all hemlock and pine timber, plank, and boards, which may be required for foundations, sheet piling, and shoreing, including the labor of framing and placing the same in the work complete, at the rate of

dollars per M. feet, board measure.

For all oak timber, etc., which may be required to be planed, framed, and set up at the waste weirs, gate chambers, etc., at the rate of

dollars per M. feet, board measure.

For all wrought iron work, put in the work, at the rate of cents per pound.

The prices above specified are to be considered as including all of the labor and materials for constructing coffer dams, and temporary protections for executing the work, and for the bailing and draining of water, and for all the machinery and implements necessary for the performance of the work herein contracted for. And also to be in full compensation for all the materials and labor required to put the same into the work herein contracted for, and complete the same in all respects, as provided in this contract.

On or before the fifteenth day of each month, the said Commissioners will pay by draft as before mentioned, to the said Contractor within ten percent of the sum which the said Engineer shall determine to be a safe relative estimate of the value of the work done during the preceeding month. The said estimate shall not be required to be made by strict measurement, but may be arrived at approximately according to the judgment of the said Engineer.

It is expressly understood, that such estimates shall only be made when the work progresses as rapidly as may be required by the said Commissioners, and in accordance with the provisions of this contract.

It is also mutually agreed, that in the event of the said Contractor failing to pay the workmen employed on this contract, the said Commissioners shall withhold the amount due to such workmen from the said estimates, and shall pay over the same under any legal requisition, and shall deduct the amount of such payments from any monies due to the said Contractor under this contract.

And it is further agreed, that if in the opinion of the said Engineer, the said Contractor shall neglect or refuse to prosecute the work embraced in this contract, or violate any of its provisions, or perform the work in an improper manner, the said Engineer may certify the same in writing to the said Commissioners, who shall thereupon serve one copy of the same on the said Contractor and one upon each of the sureties; and the said Commissioners shall have power to certify and declare that this contract has been violated and abandoned on the part of the said Contractor ; and on the making of such certificates the said contract shall be deemed abandoned, and the said Commissioners may proceed to contract for the work with any other person.

The percentage which may have been retained from time to time at the monthly estimates, and all other monies which may be due to the said Contractor under this contract, may be, at the discretion of the said Commissioners, forfeited to the city of Albany.

And the said Contractor further covenant and agree , that will commence the work herein contracted for, within ten days after this instrument has been ratified by Common Council of the city of Albany, and that this contract shall be fully completed and performed on

part, by the day of in the year eighteen hundred and fifty-

And it is further agreed, that whenever this contract, in the opinion of the said Engineer, shall be completely performed on the part of the said Contractor , the said Engineer shall proceed with all reasonable diligence to measure up the work, and shall make out the final estimate for the same, and shall certify the same to the said Commissioners, who shall within thirty days after the receipt of such certificate, pay to the said Contractor the balance which shall be found to be due, by a draft on the Chamberlain of the city of Albany.

It is to be further understood, that all of the materials and work shall be subject at all times to the inspection of the said Commissioners, of the said Engineer and his Assistants, and of Inspectors duly appointed; and that all directions which may be given by them to carry out the intent and understanding of this contract, shall be complied with on the part of the said Contractor and the workmen in employ.

It is further mutually agreed, that in the absence or inability to act, of the said Chief Engineer, then and in that case the Resident Engineer in the employment of the said Commissioners, is hereby invested with all the powers herein before given to the said Chief Engineer.

Signed, sealed and delivered, }
in the presence of, }

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